DOCUMENT RESUME

ED 111 944 CE 004 664

TITLE	Automotive Technology. Career Education Guide.
INSTITUTION	Dependents Schools (DOD), Washington, D.C. European Area.
REPORT NO	USDESEA-Man-352-356-1
PUB DATE	1 May 74
NOTE	120p.; For related documents, see CE 004 659-660 and CE 004 662-669; Twelve wall charts supporting the guides are available from Directorate, United States Dependents Schools, European Area, Dept of the Army. APO 0 9164 (Reference Wall Chart B, MAN 352-6, numbers 1-4)
EDRS PRICE	MF-$0.76 HC-$5.70 Plus Postage
DESCRIPTORS	Auto Body Repairmen; *Auto Mechanics; Auto Mechanics (Occupation); Behavioral Objectives; *Career Education; Course Descriptions; *Curriculum Guides; *Engines; Instructional Materials; Job Training; Laboratory Procedures; Learning Activities; Mechanics (Process); Secondary Education; Trade and Industrial Education; *Welding

ABSTRACT

The curriculum guide is designed to provide students with realistic training in automotive technology theory and practice within the secondary educational framework and to prepare them for entry into an occupation or continuing postsecondary education. The learning modules are grouped into three areas: small engines, automotive technology, and welding. Each unit plan consists of a description of the area under consideration, estimated hours of instruction, behavioral objectives, a module outline, a list of useful curriculum materials and resources, laboratory activities, and laboratory materials. The automotive occupations curriculum covers the following topics: basic small engine operation and construction, motorcycle repair, rotary engine power mechanics, marine engine repair, automobile operation and construction, basic tune-up, basic engine operation and construction, brake systems, power transmission systems, engine overhaul and repair, fuel system, electrical system, ignition systems, automotive parts, automotive maintenance, painting fundamentals, painting applications, body repair, welding, welding fundamentals, basic fusion and nonfusion processes, reading shop drawings, arc welding, gas welding, cutting, welding applications, and inert gas shielded-arc welding. The document concludes with facility layouts of functional auto mechanics, small engines, and welding laboratories. (BP)

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Career Education Guide

AUTOMOTIVE TECHNOLOGY

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EUROPEAN AREA
APO 09164

M A N U A L,)
No. 352-356-1)

1 May 1974

EDUCATION

Career Education - Automotive Technology

This Career Education guide is an official publication of the Directorate, United States Dependents Schools, European Area. It is designed to serve as a curriculum guide for the automotive technology cluster. The principal will establish adequate accountability procedures for all copies issued.

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FOREWORD

Automotive Technology is one area of study which never seems to suffer from lack of student motivation. There is seldom a teenager who is not captivated by the desire to possess that "first" car. The interesting thing is that the fascination with the automobile and powerful machines doesn't fade with age. This fact is proven by the better than eighty-eight million automobiles registered in the United States today.

The opportunity for service occupations in the power mechanics field becomes obvious when it is realized that the demand for automotive mechanics alone is estimated at twenty thousand yearly. Add to this the ever-increasing market for recreation vehicles, power tools, and marine engines and the career prospects are bright indeed.

Unfortunately, most training programs at the secondary level only qualify as exploratory or "crafts." This automotive technology program is designed to go beyond the tinkering stage. The suggested learning modules are designed to lead to the achievement of entry level skills in many of the power mechanics occupations. The combination of theory with hands-on shop experience insures that the initial enthusiasm of the student will be maintained throughout the program. The achievement of completed jobs is a source of continuing satisfaction and reinforcement to the student and the goal of ready employment is strong motivation.

The Automotive Technology Career Cluster chart visualizes the various alternative prospects available in this vast field. The suggested modules for achieving skills in a specific occupation are indicated. The requirements preparation chart describes the academic requirements specified for various careers in the area of automotive technology.

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PURPOSE OF THE GUIDE

This Career Opportunity Guide is prepared to assist in implementing a suggested learning system designed to provide the student with entry-level skills to numerous jobs in the broad field of Automotive Technology. The system also provides a substantial base for the student who decides to extend his career potential by continuing professional study at a community college, a four-year college, or technical school.

This guide should also suggest to instructors of differing disciplines possible applications of the modules described to satisfy needs of students in their own areas. Cooperation among instructors and administrators and individual imagination are the only limiting factors.

The guide describes each of the elements in the system which will assist instructors and administrators in implementing the career program. It is not a study guide but includes enough information for the prospective instructor to plan his course with his own special requirements and preferences in mind.

In addition to the program outline, there are lists of references, equipment, and materials as well as distributor sources.

DESCRIPTION OF LEARNING SYSTEM

The Automotive Technology Career Cluster is a two-year program which considers the needs, capabilities, background, and interests of each student enrolled. Instruction must, therefore, be individualized to the greatest extent possible considering the time and resources available. The routine classroom lecture should be reduced in its role as the primary teaching method. It should be used merely to introduce broad areas and should permit the students to discover details in small groups or on their own. Individualized learning depends heavily upon self-instructional materials, audio-visual learning aids, and student tutors.

To operate successfully, the learning environment must be free and open, but well ordered and managed with specific objectives in mind. Given such an environment, each student enters at his or her own level of achievement and moves along at his or her own rate of speed. A contract system may be used to monitor and improve upon the achievement rate. Progress is measured against individual performance rather than against that of the class as a whole. This allows students of all ability ranges to be in the same class. The high achievers can move ahead freely without being hampered by their slower classmates and can explore enrichment quests on their own. On the other hand, low achievers, already discouraged by repeated failures, are not threatened by further failure. They start wherever they are academically and attitudinally and immediately receive positive experiences which encourage them to progress.

Students need not accomplish modules in the same order. The instructor may prescribe or may negotiate with the student a selection of modules to accomplish a particular student's career goal, depending upon the student's interests and achievement level. Evaluation through pretesting may indicate that a student can skip over an entire module or part of a module.

The role of instructor becomes one of learning facilitator. The instructor prescribes the framework and procedures whereby the learner can accomplish the terminal performance objectives which will be consistent with the entry-level requirements for the career goal.

The wide cross section of learning modules suggested in this career cluster is designed to provide as great a selection of job entry-level skills as appears practical considering resource and time restraints. Individual requirements differ from school to school; therefore, the design of this learning system provides for the selection of modules to satisfy particular needs.

SUGGESTIONS FOR ORGANIZATION OF INSTRUCTION

In order to facilitate the student's completion of performance objectives in the learning system and to provide for necessary management, the following list of instructor objectives is recommended:

1. Acquaint students with class procedures.

2. Provide students with assistance in module sequencing with career goals in mind.

3. Establish small groups for study and activity purposes.

4. Encourage peer tutoring.

5. Distribute all module objectives to students and assist in relating these objectives to entry-level skill requirements.

6. Assist students in completing performance objectives by providing demonstrations of skills and concepts for each module of instruction.

7. Develop individual contracts with students defining related learning activities.

8. Provide opportunities where students can observe the activities of individuals in a variety of jobs in the career field and assist students to relate the educational goals of the learning system to the development of entry-level skills.

9. Construct and evaluate pre-tests and post-tests for each module.

10. Construct reading assignment and audio-visual review lists for each module.

11. Provide trays, drawers, or learning stations with the appropriate materials and instructions to complete laboratory activities.

12. Maintain an attractive and stimulating working environment and encourage students to display their projects or materials collected from related fields of study.

13. Invite guest speakers to discuss appropriate topics related to the field of study.

14. Encourage and actively recruit students of different disciplines to work on modules in this career cluster which may have applications for their field.

15. Encourage students working in this career cluster to examine objectives of modules in other areas with a view toward possible application to their goals.

AUTOMOTIVE TECHNOLOGY CAREER CLUSTER CHARTS

The curriculum of the Automotive Technology Career Cluster is designed to prepare students for entry into one of a broad selection of occupations or continuing post-secondary education.

The relationship of the courses or modules to preparation for entry into particular jobs has been shown on the wall charts labeled:

- Automotive Technology Career Cluster

- Preparation Requirements for Automotive Technology Careers

COURSE MODULES AND LENGTH OF INSTRUCTION

This career cluster as outlined allows for a variety of career programs ranging from less than a semester to two years of training. Since the curriculum calls for individualized learning and students work at different rates of performance, it is difficult to specify exact times for accomplishment. The following list, therefore, shows an approximation of the average student time it takes to accomplish the performance objectives and is useful only as a general reference for planning.

Module	Estimated Learning Time in Hours
Orientation to Small Engines	5
Basic Small Engine Operation and Construction	60
Motorcycle Repair	24
Rotary Engine Power Mechanics	30
Marine Engine Repair	24
Orientation to Automotive Technology	5
Automobile Operation and Construction	90
Basic Tune-Up	50
Basic Engine Operation and Construction	50
Automotive Brake Systems	42
Automotive Power Transmission Systems	30
Engine Overhaul and Repair	30
Automotive Fuel System	30
Automotive Electrical System	30
Automotive Ignition Systems	30
Automotive Parts	40
Automotive Maintenance	90
Automotive Painting Fundamentals	90
Automotive Painting Applications	90
Automotive Body Repair	100
Orientation to Welding	8
Fundamentals of Welding	12
Basic Fusion and Nonfusion Processes	30
Reading Shop Drawings	12
Arc Welding	25

Module	Estimated Learning Time in Hours
Arc Welding Applications	25
Gas Welding	12
Cutting	25
Gas Welding Applications	25
Inert Gas Shielded - Arc Welding	25

ORIENTATION TO SMALL ENGINES

DESCRIPTION

Orientation to Small Engines ... presents an overview of the field of small engine technology and is aimed at providing the student with enough information to make decisions concerning desire and ability to meet goals and objectives of this career area. Program organization, careers, shop routine, and safety procedures are established.

LEARNING TIME

Hours: 5

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Complete a standardized safety test in small engine mechanics with all questions answered correctly.
2. Describe by name and location all of the safety facilities in the shop area.
3. Identify the goals and objectives of the small engines program.
4. Identify the jobs, requirements, and rewards potentially available to students enrolled in the small engines program.

Acceptable achievement will be determined by 100% success on the standard safety test and a minimum of 80% success on objective and written tests.

MODULE OUTLINE

A. Small Engines Shop Safety
   1. safety orientation tour of shop
   2. safety instruction
   3. safety test

B. Goals and Objectives
   1. goals of program
   2. course objectives
   3. description of potential jobs

C. Student Requirements

1. study requirements
2. laboratory activities
3. materials and supplies

CURRICULUM MATERIALS

References: Small Gasoline Engines, George Stephenson, Unit 8. Delmar Publishers, Inc., 50 Wolf Road, Albany, NY 12205

All About Small Gasoline Engines, Jud Purvis. Goodheart-Willcox Company, 123 West Taft Drive, South Holland, Illinois 60473

Accident Prevention for Shop Teachers, William A. Williams. American Technical Society, 848 East 58th Street, Chicago, Illinois 60637

"Sample Safety Test" from A Suggested Guide for a Training Course - Small Engine Repair. The University of the State of New York, State Education Department Bureau of Secondary Curriculum Development, Albany, NY 12224

LABORATORY ACTIVITIES

1. Safety tour of shop
2. Demonstrate safety equipment

LABORATORY MATERIALS

Shop safety equipment

BASIC SMALL ENGINE OPERATION AND CONSTRUCTION

DESCRIPTION

Basic Small Engine Operation and Construction ... is a three-part investigation of small gasoline engines. Theories and principles as well as maintenance and servicing techniques on two-cycle and four-cycle engines are provided. The student works on actual engines, performing troubleshooting and servicing.

LEARNING TIME

Hours: 60

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Identify and describe two-cycle and four-cycle gasoline engines.
2. Disassemble, clean and inspect, and assemble the following two-cycle engine parts:
   a. carburetor
   b. magneto
   c. power head
   d. piston and rods
   e. major components
   f. engine accessories
3. Disassemble, clean and inspect and/or service, and assemble the following four-cycle engine parts:
   a. carburetor
   b. power head
   c. tappets and cams
   d. crankshaft bearings
   e. valves
   f. fuel pumps
   g. starter
   h. ignition

4. Perform basic troubleshooting and tune-up on two-cycle and four-cycle engines.
5. Demonstrate the ability to use service manuals and parts catalogs.
6. Service spark plugs.
7. Demonstrate the ability to use a torque wrench.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and 80% success in objective tests.

MODULE OUTLINE

A. Shop Orientation and Safety
B. Tools and Equipment
C. Classifications of Small Engines
D. Two-cycle Engines - Disassembly, Inspection, Assembly
   1. carburetor
   2. magneto
   3. power head
   4. major components
   5. piston and rod
   6. engine accessories
E. Four-cycle Engines
   1. carburetor servicing
   2. four-cycle carburetor
   3. cooling system
   4. electrical system
   5. using the micrometer
   6. preventive maintenance
   7. power head - disassembly, operation, assembly
   8. tappets and cams
   9. valve servicing
   10. crankshaft bearings
   11. starter servicing
   12. basic trouble diagnosis
   13. ignition servicing
   14. fuel pumps

15. using the parts catalog
16. four-cycle theory

F. Applications

1. electric starter overhaul
2. alternators/generators
3. electrical system maintenance
4. engine tune-up
5. magneto theory and testing
6. spark plug servicing
7. using torque wrenches
8. using the service manual
9. using troubleshooting charts
10. actual engine disassembly, cleaning and inspecting, and assembly

CURRICULUM MATERIALS

Self-paced Skill Training Program: Ken Cook Transnational, Automated Teaching Systems, 9919 West Silver Spring Road, Milwaukee, Wisconsin 53225

"Small Engine Technician Course," 54 automated teaching systems programs which fit the Mark 9 Student Response System and includes workbooks, test sheets, certificates, class schedule, and instructor's manual.

LABORATORY ACTIVITIES

The student will perform actual component and engine work as described in the Small Engine Technician Course cited above.

MOTORCYCLE REPAIR

DESCRIPTION

Motorcycle Repair ... provides the student with hands-on experience in repairing two-stroke and four-stroke motorcycles. Maintenance and tear-down procedures are demonstrated and practiced on the engine, brakes, transmission and clutch, ignition, electrical system, accessories and equipment. Riding and safety considerations are described.

LEARNING TIME

Hours: 24

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Identify different parts and systems of a motorcycle and their basic functions.
2. Perform basic motorcycle maintenance and tune-up.
3. Read electrical wiring diagrams.
4. Perform a comprehensive visual inspection of a motorcycle's condition and basic diagnostic tests.
5. Identify rider safety equipment and procedures.
6. Read performance specifications and repair manuals.

Acceptable achievement will be determined by successful accomplishment of shop exercises and a minimum of 80% success in objective tests.

MODULE OUTLINE

A. Basic Engine Principles: Systems and Parts and Their Functions
   1. two-stroke engines
   2. four-stroke engines

B. Lubrication and Fuel Systems
   1. oil tank, supply line, and return pipe
   2. carburetor

3. exhaust manifold
4. gas lines
5. muffler

C. Electrical and Ignition Systems
1. batteries
2. wiring
3. timing
4. points and plugs
5. circuit breaker
6. coil
7. starter
8. rectifier

D. Power Train
1. chain
2. clutch and clutch cable
3. transmission

E. Chassis Construction
1. frame
2. wheel suspension systems
3. steering

F. Brake System
1. front hand brakes
2. rear brakes

G. Riding and Safety

CURRICULUM MATERIALS

Power Mechanics, Motorcycle Repair, Hoffman Occupational Learning Systems, 4423 Arden Drive, El Monte, CA 91734

Modules:
- Theory of 2 & 4 Cycle Engine & Introduction to Power Transmissions & Fuel Systems
- Carburetion - Types of Carburetors; Repair & Overhaul
- Electrical Ignition Timing, System & Schematics
- General Servicing, Harley Distributor Overhaul
- Engine Servicing & Overhaul
- General Motorcycle
- Front Forks & Brake Systems (Drum & Disc)

Motorcycle Repair Manual, revised edition (1973). Petersen Publishing Company, 8490 Sunset Boulevard, Los Angeles, CA 90069

Glenn's Motorcycle Repair Guide as appropriate for vehicle being worked on. Henry Regnery Company, 114 Illinois Street, Chicago, Illinois 60610 and Crown Publishers, 419 Park Ave., New York, NY 10016

LABORATORY ACTIVITIES

Shop sessions require hands-on involvement:

1. Major tune-up
2. Basic maintenance servicing/major tune-up
3. Brakes and clutch
4. Power train

LABORATORY MATERIALS

1. For engine and bench activities see Basic Small Engine Operation and Construction course
2. For activities pertaining to areas other than engine, the student should have access to a motorcycle

ROTARY ENGINE POWER MECHANICS

DESCRIPTION

Rotary Engine Power Mechanics ... is an enrichment module designed to familiarize the student with rotary engine theory and practical hands-on skill training. The engine studied is a small marine version of the Wankel-type engine. Instruction is completely automated and self paced and covers six major areas of study: fuel system, ignition system, power head, major components, special servicing, and rotor. The student will disassemble, inspect, troubleshoot, and reassemble the engine.

LEARNING TIME

Hours: 30

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Disassemble, clean, and inspect fuel system components.
2. Identify characteristics and functions of major parts of fuel system.
3. Reassemble fuel system.
4. Remove and inspect ignition system components.
5. Identify characteristics and function of major parts of ignition system.
6. Test and troubleshoot ignition components.
7. Reassemble ignition system.
8. Disassemble, clean, and inspect power-head parts.
9. Reassemble power-head parts.
10. Remove, inspect, clean, and replace rotor seal.
11. Disassemble, inspect, and reassemble starter.
12. Describe operation of charging system and read wiring diagram.
13. Troubleshoot Wankel engine.

Acceptable achievement will be determined by the student's ability to perform steps of automated learning program, make proper responses to program, and maintain a minimum of 80% success in prepared program tests.

MODULE OUTLINE

A. Fuel System
   1. theory
   2. disassembly
   3. cleaning and inspection
   4. reassembly

B. Ignition System
   1. component removal
   2. theory and inspection
   3. troubleshooting and testing
   4. component installation

C. Power Head
   1. disassembly
   2. inspection
   3. reassembly

D. Major Components
   1. disassembly
   2. inspection and function
   3. reassembly

E. Special Servicing
   1. starter disassembly, inspection, and reassembly
   2. charging system, wiring diagram
   3. troubleshooting Wankel engine

F. Rotor
   1. rotor seal removal
   2. rotor cleaning and inspection
   3. rotor seal installation

CURRICULUM MATERIALS

Self-paced Skill Training Program: Ken Cook Transnational, Automated Teaching Systems, 9919 West Silver Spring Road, Milwaukee, Wisconsin 53225

"The Wankel Engine Technician Course," 18 automated programs of hands-on instruction which fit the Mark 9 Student Response System and includes workbooks, test sheets, certificates, class schedule, and instructor's manual.

LABORATORY ACTIVITIES

The automated learning system provides hands-on experience as the student disassembles, inspects, troubleshoots, and reassembles an outboard (marine) Wankel-type engine.

MARINE ENGINE REPAIR

DESCRIPTION

Marine Engine Repair ... prepares potential outboard engine repairmen with service and repair procedures as they apply to a typical small outboard motor.

LEARNING TIME

Hours: 24

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Disassemble, clean and inspect, and assemble the
   a. power head
   b. magneto and starter
   c. fuel system
   d. lower unit
   e. gearcase
   f. generators/alternators and rectifiers
   g. steering assembly
2. Perform visual inspection and diagnostic testing of a typical small outboard motor.
3. Perform tune-up of a typical small outboard motor.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and 80% success in objective tests.

MODULE OUTLINE

A. Marine Engines - Introduction

B. Developing Techniques for Disassembly, Cleaning and Inspection, and Assembly
   1. engine power head

2. engine magneto and starter
3. engine fuel systems
4. engine lower unit
5. engine gearcase
6. engine major components

CURRICULUM MATERIALS

Self-paced Skill Training Program: Ken Cook Transnational, Automated Teaching Systems, 9919 West Silver Spring Road, Milwaukee, Wisconsin 53225

"Marine Engine Technician," set of 18 workstation programs which fit the Mark 9 Student Response System and includes workbooks, test sheets, certificates, class schedule, and instructor's manual.

LABORATORY ACTIVITIES

The student will perform disassembly, cleaning and inspection, and assembly of Evinrude 6 HP outboards and subassemblies as described in the Marine Engine Technician self-paced program described above.

ORIENTATION TO AUTOMOTIVE TECHNOLOGY

DESCRIPTION

Orientation to Automotive Technology ... presents an overview of the field of automotive engine technology and is aimed at providing the student with enough information to make decisions concerning desire and ability to meet the goals and objectives of this career cluster. The student becomes aware of the requirements and operation of the course and is familiarized with the career potential of this ever-expanding service field. Safety instruction informs the student of potential dangers which exist in the shop environment and how to avoid doing harm to others or oneself. A standardized safety test is administered as proof of safety instruction.

LEARNING TIME

Hours: 5

OBJECTIVES

Given appropriate instruction and materials, the student will be able to:

1. Complete a standardized safety test in auto mechanics with all questions answered correctly.
2. Describe by name and location all of the safety facilities in the shop area.
3. Identify the goals and objectives of the auto mechanics program.
4. Identify the jobs, requirements, and rewards potentially available to students enrolled in the auto mechanics program.

Acceptable achievement will be determined by 100% success on the standard safety test and a minimum of 80% success on objective and written tests.

MODULE OUTLINE

A. Auto Mechanics Safety

   1. safety orientation tour of shop

2. safety instruction
    a. lecture
    b. safety booklet
3. safety test

B. Goals and Objectives
1. goals of program
2. course objectives
3. description of potential jobs

C. Student Requirements
1. study requirements
2. laboratory activities
3. materials and supplies

CURRICULUM MATERIALS

Automotive Mechanics (text), 6th edition, William Crouse. McGraw-Hill, Inc., 330 West 42nd Street, New York, NY 10036

Student Guide for Safety Instruction in Auto Mechanics, No. 41-5-0020, San Diego City Schools, Programs Division, Education Center, 4100 Normal Street, San Diego, CA 92103

Safety Test Question Booklets, No. 31-5-0020, San Diego City Schools

Safety Test Answer Sheets, No. 31-5-0065, San Diego City Schools

LABORATORY ACTIVITIES

1. Safety tour of shop
2. Demonstrate safety equipment

LABORATORY MATERIALS

Shop safety equipment

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AUTOMOBILE OPERATION AND CONSTRUCTION

DESCRIPTION

Automobile Operation and Construction ... describes the various systems of the automobile and shows how these systems relate to each other and the automobile as a whole. The purpose of each system as well as the major components is explained. This module provides a basic awareness of automobile construction from which the student can progress to specific areas of study in auto mechanics.

LEARNING TIME

Hours: 90

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Identify the purpose of each automotive system.
2. Differentiate between automotive components according to systems.
3. Identify major automotive components by sight.
4. Describe the relationships between automotive systems.

Acceptable achievement will be determined by a minimum of 80% success on objective and written tests.

MODULE OUTLINE

A. Power Train
   1. engine
   2. power transmission
   3. drive line
   4. differential

B. The Chassis
   1. frame
   2. suspension system

3. steering system

C. The Body

1. body styles
2. body construction
3. body components

D. Operational Systems

1. cooling system
2. brake system
3. fuel system
4. starting system
5. charging system
6. ignition system

CURRICULUM MATERIALS

Automotive Mechanics (text), 6th edition, William Crouse, chapters 3, 4, and 5. McGraw-Hill, Inc., 330 West 42nd Street, New York, NY 10036

References: Auto Mechanics, Glenn. Charles A. Bennett Co., Inc., 809 Detweiler Drive, Peoria, Illinois 61614

Auto Encyclopedia, Toboldt. Goodheart-Willcox Company, 123 West Taft Drive, South Holland, Illinois 60473

Films: General Motors Corporation, Educational Relations Section, Warren, Michigan

"Where Mileage Begins," 16mm/color

LABORATORY ACTIVITIES

Rotating through separate learning stations on each of the operational systems, the student will perform the following activities at each station:

1. Identify the major components of the system
2. Trace the system
3. Perform common component replacement tasks
4. Identify common problems
5. Place the system in working order

BASIC TUNE-UP

DESCRIPTION

Basic Tune-up ... is a combined study of the fuel, ignition, and positive crankcase ventilation (PCV) automotive systems. The module covers the fundamentals of each system and provides laboratory activities which constitute a minor engine tune-up. Methods and tools that the student can use at home are stressed to provide maximum retention.

LEARNING TIME

Hours: 50

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Describe the operation of the fuel, ignition, and positive crankcase ventilation (PCV) systems.
2. Perform minor tune-up operations.
3. Identify ignition, fuel, and PCV system components.
4. Perform engine test operation.
5. Identify the purpose and function of ignition, fuel, and PCV system components.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success in written and objective tests.

MODULE OUTLINE

A. Fuel Systems
   1. purpose
   2. fuel tanks
   3. fuel pumps
   4. carburetion
   5. air cleaners
   6. fuels

B. Ignition Systems

1. purpose
2. system components
3. primary ignition system
4. secondary ignition system
5. ignition timing

C. Engine Testing

1. cylinder compression loss
2. engine vacuum
3. defective cylinders

D. Positive Crankcase Ventilation (PCV) System

1. purpose
2. operation
3. components

CURRICULUM MATERIALS

Automotive Mechanics (text), 6th edition, William Crouse, chapters 15, 26, and 27. McGraw-Hill, Inc., 330 West 42nd Street, New York, NY 10036

Auto Mechanic Job Sheets, San Diego City Schools, Programs Division, Education Center, 4100 Normal Street, San Diego, CA 92103

ES and TE series: ES-24, ES-25, ES-26, ES-27, ES-28, TE-6, TE-8, TE-9, TE-10, TE-12, TE-14, TE-17, TE-18, TE-20

References: Automotive Diagnosis and Tune-up, Guy F. Wetzel. McKnight Publishing Company, Box 854, Bloomington, Illinois 61701

Glenn's Emission Control Systems, Glenn. Henry Regnery Company, 114 West Illinois, Chicago, Illinois 60610

Filmstrip: General Motors Corporation, Anderson, Indiana.

"20,000 Volts Under the Hood," 12 minutes, color, with record and script

LABORATORY ACTIVITIES

1. Adjust carburetor idle speed and mixture
2. Test fuel pump
3. Disassemble and assemble a model B Rochester carburetor
4. Service air cleaner

5. Remove, adjust and replace spark plugs
6. Replace ignition points and condensor
7. Set ignition timing
8. Find correct firing order
9. Test engine compression
10. Test engine vacuum
11. Make dynamic compression check
12. Service PCV system
13. Test PCV system

BASIC ENGINE OPERATION AND CONSTRUCTION

DESCRIPTION

Basic Engine Operation and Construction ... familiarizes the student with operating principles of the four-stroke reciprocating automobile engine. The construction and components of the engine are examined and hands-on laboratory activities correlate theory with practical operation of various engine systems. The process of how the automobile engine releases the potential energy of gasoline and then converts this energy to useful power is explained.

LEARNING TIME

Hours: 50

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Identify major engine components by sight.
2. Differentiate between engine components by systems.
3. Recall the four engine strokes.
4. Differentiate valve positions, piston positions and direction of travel, and combustion chamber events according to engine stroke.
5. Remove and replace engine components.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success on objective and written tests.

MODULE OUTLINE

A. Basic Engine Construction
   1. cylinder block
   2. cylinder head
   3. piston and connecting rod assembly
   4. crankshaft

5. bearings
6. gaskets

B. Basic Engine Operation
1. combustion process
2. engine stroke cycles (2 and 4)
3. engine power flow
4. valve operation

C. Engine Support Systems
1. valve train
2. fuel system
3. ignition system
4. lubricating system
5. cooling system
6. exhaust system

CURRICULUM MATERIALS

Automotive Mechanics (text), 6th edition, William Crouse, chapters 3, 4, and 5. McGraw-Hill, Inc., 330 West 42nd Street, New York, NY 10036

Auto Mechanic Job Sheets, San Diego City Schools, Programs Division, Education Center, 4100 Normal Street, San Diego 92103

ES series: ES-1, ES-2, ES-3, ES-5, ES-6, ES-8, ES-9, ES-10, ES-14, ES-15, ES-18, ES-19, ES-20, ES-32

References: Auto Mechanics, Glenn. Charles A. Bennett Co., Inc., 809 Detweiler Drive, Peoria, Illinois 61614

Films: Aims Instructional Media Services, Inc., P.O. Box 1010, Hollywood, CA 90028

"What's Under the Hood?" 11 minutes, 16mm/color

LABORATORY ACTIVITIES

1. Remove and replace cylinder head
2. Remove and replace piston and rod assembly
3. Measure bearing clearance
4. Make a sample gasket
5. Remove and replace valves
6. Check engine valve timing
7. Disassemble and assemble hydraulic lifter

8. Adjust valve clearance
9. Remove and replace fuel pump
10. Remove and replace intake manifold
11. Remove and replace pan and gasket
12. Remove and replace exhaust manifold

LABORATORY MATERIALS

To be drawn from shop equipment supplies

AUTOMOTIVE BRAKE SYSTEMS

DESCRIPTION

Automotive Brake Systems ... is a specialized area of study for the advanced auto mechanics student. This module describes steps and procedures for the complete overhaul of drum brake and disc brake systems. Brake system components, their characteristics, and their operation are examined. The similarities and differences between disc and drum brake systems are compared. Laboratory activities provide the student with practical skills for testing, removing, repairing and replacing the various brake system components.

LEARNING TIME

Hours: 42

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Identify and describe the function of typical brake system components.
2. Perform service and overhaul operations on brake system components.
3. Describe the operation of typical brake system components and their relationship to the system as a whole.
4. Identify brake system components by sight.
5. Differentiate between disc brake and drum brake system components.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success on written and objective tests.

MODULE OUTLINE

A. Principles of Brake Operation
   1. friction
   2. hydraulic
   3. brake operation

B. Brake System Components

1. master cylinder
2. drum brake mechanisms
3. disc brake mechanisms
4. hydraulic brake fluid
5. hydraulic brake lines and fittings

C. Brake System Accessories

1. parking brake
2. power assist units
3. self-adjusting brakes

CURRICULUM MATERIALS

Automotive Mechanics (text), 6th edition, William Crouse. McGraw-Hill, Inc., 330 West 42nd Street, New York, NY 10036

Auto Mechanic Job Sheets, San Diego City Schools, Programs Division, Education Center, 4100 Normal Street, San Diego, CA 92103

CH series: CH-11 to 17, CH-28 to 31, CH-33 to 36

References: Motor's Auto Repair Manual. Motor, 250 West 55th Street, New York, NY

Automotive Chassis and Body, William Crouse. McGraw-Hill, Inc.

Auto Service and Repair, Stockel. Goodheart-Willcox Company, Homewood, Illinois 60430

Films: Raybestos-Manhattan, Inc., Bridgeport, Connecticut 06603

"Disc Brakes Today and Tomorrow," 45 minutes, 16mm/color

Self-paced Skill Training Programs: Ken Cook Transnational, Automated Teaching Systems, 9919 West Silver Spring Road, Milwaukee, Wisconsin 53225

Program 7. "Removing and Servicing Brake D[redacted]ns"

Program 8. "Removing Brake Shoes and Servicing Wheel Cylinders"

Program 9. "Installing Brake Shoes"

Program 10. "Adjusting the Brake Shoes"

Chart: National Carbon Company, 30 East 42nd Street, New York, NY

"The Hydraulic Brake System," 24" x 30" wall chart

LABORATORY ACTIVITIES

1. Overhaul master cylinder
2. Overhaul caliper assembly
3. Overhaul wheel cylinder
4. Remove and replace brake linings (disc and drum)
5. Bleed brake system
6. Adjust brakes
7. Remove and replace caliper assembly
8. Measure brake drum wear
9. Adjust parking brake
10. Test power brake unit
11. Inspect self-adjusting brakes

AUTOMOTIVE POWER TRANSMISSION SYSTEM

DESCRIPTION

Automotive Power Transmission System ... is an area of specialized study for the advanced auto mechanics student. The module examines the clutch, standard transmission, torque converter, automatic transmission, drive line differential, and rear axle assemblies. Comparison is made between standard and automatic transmissions, and the student becomes familiar with the components of each. Commonly required service and repair operations are performed on power transmission system components.

LEARNING TIME

Hours: 30

OBJECTIVES

Given the proper instruction and materials, the student will be able to:

1. Describe the operation of power transmission system components.
2. Perform service and repair operations on power transmission system components.
3. Differentiate between the operation of a clutch assembly and a torque converter.
4. Differentiate between the operation of a standard transmission and an automatic transmission.
5. Identify power transmission system components by sight.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success on written and objective tests.

MODULE OUTLINE

A. Transmission Systems
   1. clutch
   2. torque converter
   3. automatic transmissions
   4. standard transmissions

B. Drive Line

1. slip (spline) joints
2. propeller shaft
3. universal joints

C. The Differential

1. purpose and types
2. components
3. power flow
4. gear action
5. limited slip differentials

D. Axles and Bearings

1. axle shafts
2. hubs
3. bearings and seals

CURRICULUM MATERIALS

Automotive Mechanics (text), 6th edition, William Crouse, chapters 28 to 32, 35, 36. McGraw-Hill, Inc., 330 West 42nd Street, New York, NY 10036

Auto Mechanic Job Sheets, San Diego City Schools, Programs Division, Education Center, 4100 Normal Street, San Diego, CA 92103

CH series: CH-18 to 23

Automotive Transmission Repair, Hoffman Occupational Learning Systems, 4423 Arden Drive, El Monte, CA 91734

Modules: - Hydraulic Principles
- How Transmissions Operate
- Checking the Automotive Transmission
- Servicing the Automotive Transmission
- Automotive Transmission Repair and Replace

References: Automotive Transmissions and Power Trains, William Crouse. McGraw-Hill, Inc.

Motor's Auto Repair Manual. Motor, 250 West 55th Street, New York, NY

Power Goes to Work (booklet), General Motors Corporation, Detroit, Michigan

Chart: General Motors Corporation, Educational Relations Section, Warren, Michigan

"Three Speed Transmission," 22" x 34" wall chart

LABORATORY ACTIVITIES

1. Disassemble and assemble standard transmission
2. Remove and replace clutch
3. Adjust clutch
4. Remove and replace drive shaft
5. Service universal joint
6. Disassemble and assemble rear axle assembly
7. Remove and replace differential
8. Remove and replace axle bearings

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ENGINE OVERHAUL AND REPAIR

DESCRIPTION

Engine Overhaul and Repair ... is predominantly a hands-on laboratory activity which constitutes a ring and valve motor overhaul for advanced auto mechanics students. The module should only be attempted by students who have established a basic knowledge of automotive engine operation and construction. Many of the basic procedures for engine rebuilding are covered. The skills learned in this module will be useful to the student planning to become a general automotive mechanic or a specialist in engine rebuilding.

LEARNING TIME

Hours: 30

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Perform service and repair operations required in a ring and valve automobile motor overhaul.
2. Determine wear of automotive engine components.
3. Detect defects in an engine block and cylinder head.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success on objective tests.

MODULE OUTLINE

A. Cleaning and Inspection
   1. cleaning methods
   2. wear detection
   3. crack detection

B. Short Block Overhaul
   1. block service
   2. piston and connecting rod service

3. crankshaft service
4. bearing service
5. gasket replacement
6. short block assembly

C. Cylinder Head Overhaul
1. valve face grinding
2. valve seat grinding
3. valve train service
4. cylinder head assembly

CURRICULUM MATERIALS

Automotive Mechanics (text), 6th edition, William Crouse, chapters 3 to 8, 17, 18. McGraw-Hill, Inc., 330 West 42nd Street, New York, NY 10036

Auto Mechanic Job Sheets, San Diego City Schools, Programs Division, Education Center, 4100 Normal Street, San Diego, CA 92103

ES series: ES-4, ES-5, ES-6, ES-7, ES-15, ES-16, ES-17, ES-18, ES-29, ES-30, ES-32

Automotive Engine Repair, Hoffman Occupational Learning Systems, 4423 Arden Drive, El Monte, CA 91734

Modules: - General Automotive Shop
- Operation of Automotive Engine Systems
- Automotive Engine Measuring Procedures
- Automotive Engine Subassembly Overhaul Operations and Procedures
- Valve & Seat Refinishing
- Automotive Engine Removal & Replacement
- Distributor

References: Automotive Engine Rebuilding and Maintenance, Glenn. Chilton Book Company, 401 Walnut Street, Philadelphia, PA 19106

Auto Service and Repair, Stockel. Goodheart-Willcox Company, 123 West Taft Drive, South Holland, Illinois 60473

Auto Engines and Electrical Systems, Blanchard. Motor, 250 West 55th Street, New York, NY

Motor's Auto Repair Manual. Motor

Films: Perfect Circle Division, Dana Corporation, P.O. Box 1000, Hagerstown, Indiana 47346

"Case of the Slippery Oil," 40 minutes, 16mm/color

LABORATORY ACTIVITIES

1. Clean cylinder head and block
2. Measure piston and crankshaft
3. Check cylinder head and block for cracks
4. Ridge ream cylinder
5. Remove and replace piston and rod assembly
6. Measure bearing clearance
7. Measure crankshaft
8. Measure cylinder bores
9. Remove and replace valves
10. Reface valves
11. Reface valve seats
12. Disassemble and assemble hydraulic valve lifter

AUTOMOTIVE FUEL SYSTEM

DESCRIPTION

Automotive Fuel System ... is a specialized study for the advanced auto mechanics student. The seven common carburetor circuits and the conditions under which they operate are examined. The student becomes familiar with the various components, how they function, and their relationship with the system as a whole. Service and repair operations are performed and the student becomes proficient at carburetor overhaul.

LEARNING TIME

Hours: 30

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Identify fuel system components.
2. Perform service and repair operations on fuel system components.
3. Describe the function and purpose of fuel system components.
4. Explain how individual components relate to the fuel system as a whole.
5. Identify the carburetor system in operation during different engine operating conditions.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success on written and objective tests.

MODULE OUTLINE

A. Fuel System Operation
   1. purpose
   2. fuel tanks
   3. fuel lines, fittings and filters
   4. fuel pumps
   5. carburetors

B. Fuel Pump

1. purpose
2. location
3. construction and type
4. operation

C. Carburetion

1. physical principles
2. engine fuel requirements
3. fuel ratios - air/fuel mixture
4. carburetor systems
5. carburetor types

D. Air Cleaners

1. purpose
2. types

CURRICULUM MATERIALS

Automotive Mechanics (text), 6th edition, William Crouse. McGraw-Hill, Inc., 330 West 42nd Street, New York, NY 10036

Auto Mechanic Job Sheets, San Diego City Schools, Programs Division, Education Center, 4100 Normal Street, San Diego, CA 92103

TE series: TE-18, TE-31, TE-33, TE-34

References: Auto Engines and Electrical Systems, Blanchard. Motor, 250 West 55th Street, New York, NY

Motor's Auto Repair Manual. Motor

Automotive Fuel, Lubricating and Cooling Systems, William Crouse. McGraw-Hill, Inc.

Self-paced Skill Training Program: The Automotive Fuel System, Echlin Manufacturing Company, Branford, Connecticut. Slides - script - learning aids - workbooks

Chart: General Motors Corporation, Educational Relations Section, Warren, Michigan

"Automobile Fuel System," multicolored wall chart

LABORATORY ACTIVITIES

1. Test fuel pump
2. Disassemble, assemble, and adjust a Rochester 2G carburetor
3. Disassemble, assemble, and adjust a Carter BBD carburetor
4. Service an air cleaner
5. Test temperature-modulated air cleaner

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AUTOMOTIVE ELECTRICAL SYSTEM

DESCRIPTION

Automotive Electrical System ... provides a specialized area of study for advanced auto mechanics students. The relationship between the charging system and the total electrical system is explored. A basic understanding of electricity and electromagnetism is required. Electrical system components are explained and testing and repair procedures are performed.

LEARNING TIME

Hours: 30

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Describe the purpose of the generating and starting systems.
2. List electrical components according to type of system.
3. Identify electrical system components by sight.
4. Perform service and repair operations on electrical system components.
5. Describe the purpose and function of electrical system components.
6. Describe how the electrical system relates to other automotive systems.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success on objective and written tests.

MODULE OUTLINE

A. Electrical System Operation
   1. purpose
   2. components
   3. fundamentals of electricity review
   4. magnetism and electromagnetism

B. Charging System

1. battery
2. generators
3. alternators
4. regulators
5. charging circuit

C. Starting System

1. battery
2. starter motor
3. starter drives
4. solenoids and relays

CURRICULUM MATERIALS

Automotive Mechanics (text), 6th edition, William Crouse, chapters 13, 14, 16, 23, 24. McGraw-Hill, Inc., 330 West 42nd Street, New York, NY 10036

Auto Mechanic Job Sheets, San Diego City Schools, Programs Division, Education Center, 4100 Normal Street, San Diego, CA 92103

TE series: TE-3, TE-19, TE-26 to TE-30

Automotive Engine Repair, Hoffman Occupational Learning Systems, 4423 Arden Drive, El Monte, CA 91734

5.8.1 "Electrical Systems" from Operation of Automotive Engine Systems

Automotive Tune-Up, Hoffman Occupational Learning Systems

Modules: - Basic Electrical Theory & Test Equipment
- Electrical Storage System
- Electrical System Starting Circuits
- Charging Circuits - D.C. Generator Theory & Testing
- Charging Circuits - A.C. Alternator Theory & Testing
- Ignition Theory & Wiring
- Coil & Condenser
- Distributors & Timing Procedures
- Spark Plugs

References: Motor's Auto Repair Manual. Motor, 250 West 55th Street, New York, NY

Auto Engines and Electrical Systems, Blanchard. Motor

Automotive Electrical Equipment, William Crouse. McGraw-Hill, Inc.

Filmstrips: General Motors Corporation, Delco-Remy Division, Anderson, Indiana

"The Cranking Circuit," 12 minutes, record - script

"Regulation and the Charging Circuit," 12 minutes, record - script

Film Loops: Universal Education and Visual Arts, 100 Universal City Plaza, Universal City, CA 91608

"The Alternator," Part I and II, complete set of 14 color loops

LABORATORY ACTIVITIES

1. Test battery capacity
2. Overhaul generator
3. Test alternator and regulator output
4. Remove, replace, and polarize regulator
5. Disassemble and assemble an alternator
6. Test alternator circuits
7. Test starter current draw
8. Overhaul starter motor
9. Remove and replace starter drive
10. Remove and replace solenoid
11. Test starter circuit voltage
12. Test starter circuit resistance
13. Disassemble and assemble starter motor

AUTOMOTIVE IGNITION SYSTEMS

DESCRIPTION

Automotive Ignition Systems ... is a specialized area of study for the advanced auto mechanics student. Ignition system components, their characteristics and operation, are examined. The student becomes familiar with the location of each component in relation to the primary or secondary ignition system. The combined laboratory activities constitute a major electrical tune-up.

LEARNING TIME

Hours: 30

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Perform service and repair operations on an ignition system (tune-up).
2. Identify ignition system components by sight.
3. Describe the function and purpose of ignition system components.
4. Explain how ignition system components relate to each other and the ignition system as a whole.
5. Explain how ignition system components relate to the engine.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success on written and objective tests.

MODULE OUTLINE

A. Ignition System Components, Construction, and Operation
   1. distributor
   2. coil
   3. spark plugs
   4. primary and secondary wires

B. Primary Ignition System

1. breaker points
2. condenser
3. primary coil windings
4. primary resistance circuit
5. primary circuit

C. Secondary Ignition System

1. distributor cap and rotor
2. secondary coil windings
3. secondary ignition wires
4. spark plugs

D. Ignition Timing and Advance

1. ignition timing (crankshaft position)
2. ignition advance
3. vacuum advance
4. centrifugal advance

CURRICULUM MATERIALS

Automotive Mechanics (text), 6th edition, William Crouse, chapters 15, 25, 27. McGraw-Hill, Inc., 330 West 42nd Street, New York, NY 10036

Auto Mechanic Job Sheets, San Diego City Schools, Program Division, Education Center, 4100 Normal Street, San Diego, CA 92103

TE series: TE-9 to TE-15, TE-21

References: Auto Engines and Electrical Systems, Blanchard. Motor, 250 West 55th Street, New York, NY

Glenn's Emission Control Systems, Glenn. Henry Regnery Company, 114 West Illinois, Chicago, Illinois 60610

Automotive Diagnosis and Tune-up, Wetzel. McKnight Publishing Company, Box 854, Bloomington, Illinois 61701

Teacher's Kit, packet of materials. Champion Spark Plug Company, P. O. Box 910, Toledo, Ohio 43601

Films: Porta Corporation

"Spark in Time on the Firing Line," 16mm/color

Self-paced Skill Training Program: Technical Ignition Course, Echlin Manufacturing Company, Branford, Connecticut

Charts: General Motors Corporation, Delco-Remy Division, Anderson, Indiana

"The Ignition System," (section D), series of 26" x 36" wall charts

LABORATORY ACTIVITIES

1. Remove and replace breaker points
2. Remove and replace condenser
3. Adjust dwell
4. Trace primary ignition circuit
5. Remove and replace cap and rotor
6. Remove and replace coil
7. Trace secondary ignition system
8. Remove, replace, and gap spark plugs
9. Remove and replace distributor
10. Set ignition timing
11. Test distributor advance functions
12. Find correct firing order

AUTOMOTIVE PARTS

DESCRIPTION

Automotive Parts ... provides a foundation of knowledge of automotive parts required to perform as an effective automotive parts counterman. The student will use various manufacturers' catalogues and price lists and be exposed to purchasing, storage, and selling processes. Mathematical problems common to the field and the measurement of parts is included.

LEARNING TIME

Hours: 40

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Solve common mathematical problems in addition, subtraction, multiplication, and division encountered by the counterman; includes use of:
   a. percentages
   b. discounts
   c. markups
2. Determine correct dimensions of automotive parts using the metric scale or rule, hand caliper, and/or the micrometer.
3. Identify and explain the function of the parts listed below with a minimum of technical terminology:

   A. Cylinder Head Parts

   1. variety of gaskets
   2. rocker arm
   3. intake manifold
   4. valve lifter
   5. intake and exhaust valves
   6. valve keepers
   7. piston rings
   8. pistons
   9. connecting rod bearings
   10. vibration dampener
   11. camshaft bearings
   12. main bearings
   13. timing gears
   14. motor mounts
   15. rocker arm cover
   16. exhaust manifold
   17. pushrod
   18. cylinder head
   19. valve springs
   20. valve stem seals
   21. fan belts
   22. connecting rods

23. water pump
24. camshaft
25. crankshaft
26. timing chain
27. oil pump
28. expansion plugs

B. Transmission Parts

1. bushings
2. clutch plates
3. front pump assembly
4. main drive gear
5. low gear
6. reverse gear
7. main shaft
8. countershaft gear
9. drive pinion

C. Wheel and Brake Parts

1. front wheel bearings
2. front wheel seals
3. wheel cylinders
4. power brake unit
5. brake shoe
6. brake springs
7. master cylinder repair kit
8. brake cable
9. rear wheel bearings
10. rear wheel seals
11. master cylinder
12. brake lining
13. brake drum
14. wheel cylinder repair kit
15. brake hose

D. Fuel Pump and Carburetor Parts

1. single fuel pump
2. double fuel pump
3. two barrel carburetor
4. four barrel carburetor
5. carburetor tune-up kit

E. Major Clutch Parts

1. clutch plate
2. clutch cover assembly
3. clutch throwout bearing
4. clutch release bearing or bushing

F. Ignition Parts

1. distributor cap
2. distributor points
3. distributor condensor
4. rotor
5. vacuum control
6. coil
7. voltage regulator
8. generator
9. alternator
10. starter
11. starter solenoid
12. resistor spark plug wire

G. Major Chassis Parts

1. ball joint assembly
2. king bolts
3. tie rod ends
4. tie rod assembly
5. exhaust pipe
6. control arm shaft assembly
7. idler arm assembly
8. idler arm kit
9. shock absorbers
10. universal joint kit
11. tailpipe
12. spring shackle
13. universal joints
14. muffler

H. Major Auto Body Parts

1. roof
2. hood
3. deck lid
4. front fenders
5. rear fenders
6. quarter panel
7. bumpers
8. grills
9. door
10. door panel
11. extensions

I. Major Auto Body Mouldings

1. body
2. fender
3. hood
4. wheel opening
5. door
6. quarter panel
7. rocker reveal
8. windshield
9. headlights
10. trunk
11. gutter

J. Tools

1. staple applicators
2. slip joint pliers
3. wire strippers
4. box wrenches
5. torque wrench
6. Allen wrench
7. impact wrench
8. ball peen hammer
9. bumping hammer
10. ratchet screwdriver
11. Phillips screwdriver
12. needle nose pliers
13. spring retracting pliers
14. terminal applicators
15. end wrenches
16. offset wrench
17. spanner wrench
18. chain wrench
19. chipping hammer
20. stub screwdriver
21. offset screwdriver
22. tube flarer

K. Service Equipment

1. fan belt measurer
2. battery tester
3. pressure gauge
6. battery charger
7. dynamometer
8. vacuum gauge

4. Identify the required related parts for the specific job:
   a. ring job
   b. brake job
   c. valve grind job
   d. tune-up
5. Set up and use an organized stockroom
6. Locate and assemble random customer requests
7. Identify and price random parts requests using a variety of manufacturers' price lists

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8. Identify and explain the meaning of pricing terms in a variety of manufacturers' catalogues including:
   a. list prices
   b. car dealer price
   c. stocking dealer price
   d. quantity discount
   e. resale price to retailer
   f. repair shop price
   g. fleet price
   h. chain discount
   i. dealership wholesale compensations
9. Prepare invoices for different situations.
10. Identify and explain a variety of standard forms including:
   a. shipping orders
   b. credit memos
   c. purchase orders
11. Describe the major responsibilities of a shipping clerk, receiving clerk, and an inventory clerk.
12. Demonstrate effective sales communication techniques in
   a. face-to-face encounters
   b. telephone conversations
   c. correspondence

Acceptable achievement will be determined by an 80% successful achievement in objective tests and successful accomplishment of laboratory exercises.

MODULE OUTLINE

A. Mathematics and Parts
   1. percentages, discounts, and markups
   2. using the hand caliper, micrometer, metric scale or rule
   3. cylinder head parts
B. Transmission Parts
C. Wheel and Brake Parts
D. Fuel Pump and Carburetor Parts
E. Clutch Parts

F. Ignition Parts

G. Major Chassis Parts

H. Major Auto Body Parts

I. Auto Body Mouldings

J. Tools and Service Parts

K. Equipment

L. List Requests for Common Jobs:

1. ring job
2. brake job
3. tune-up
4. valve grind

M. Stocking Procedures

1. stockroom procedure
2. catalogues
3. invoices
4. shipping, receiving, inventory

N. Customer Relations and Sales

1. attributes of good sales personnel
2. the face-to-face encounter
3. selling techniques
   a. face to face
   b. telephone
   c. use of notes

CURRICULUM MATERIALS

Parts catalogues from various manufacturers

LABORATORY ACTIVITIES

Role play pricing and selling sessions including use of catalogues, telephone, face-to-face encounters.

LABORATORY MATERIALS

None specified

AUTOMOTIVE MAINTENANCE

DESCRIPTION

Automotive Maintenance ... provides the student with the skills and knowledge to become an informed automotive consumer. The student will continue to benefit from the activities practiced in this module as long as he or she owns a motor vehicle. The design of this module will also test the student's abilities and interest to pursue further a career in automotive technology. The student will perform maintenance and service operations on the battery, cooling system, suspension system, and steering system of the automobile. Test and maintenance of the brake system and typical chassis lubrication operations are performed. All maintenance operations can be performed at home to stress maximum retention.

LEARNING TIME

Hours: 90

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Recognize the need for automobile maintenance.
2. Perform maintenance operations on each of the automotive systems described in the module.
3. Describe how to perform maintenance operations.
4. Determine if components are in need of repair or replacement.
5. Categorize automotive components according to systems.
6. Describe the characteristics and function of each of the following systems:
   a. cooling
   b. lubrication
   c. brake
   d. suspension

Acceptable achievement will be determined by successful accomplishment of laboratory exercises and a minimum of 80% success on written and objective tests.

MODULE OUTLINE

A. Battery
   1. purpose
   2. construction
   3. principles of operation
   4. battery ratings

B. Lubrication
   1. engine
   2. steering and suspension
   3. transmission and differential
   4. body and accessory

C. Cooling System
   1. purpose
   2. types
   3. components
   4. pressurized system
   5. coolants
   6. heater systems

D. Suspension and Steering System
   1. operation of each
   2. suspension
   3. steering
   4. tires and wheels

E. Brake System
   1. operation
   2. components
   3. disc brakes
   4. brake system accessories

F. Safety Checks
   1. body
   2. engine
   3. electrical
   4. ignition

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5. lighting

6. chassis

CURRICULUM MATERIALS

Automotive Mechanics (text), 6th edition, William Crouse, chapters 20, 21, 22, 39, 40, 42. McGraw-Hill, Inc., 330 West 42nd Street, New York, NY 10036

Auto Mechanic Job Sheets, San Diego City Schools, Program Division, Education Center, 4100 Normal Street, San Diego, CA 92103

CH and TE series: CH-1 to CH-13, CH-24 to CH-28, CH-32, TE-1, TE-2, TE-3, TE-5

References: Lubrication Manual, Standard Oil Company of California, 225 Bush Street, San Francisco, CA 94104

Film Loops: Universal Education and Visual Arts, 100 Universal City Plaza, Universal City, CA 91608

7770 Disc Brakes Series, set of 8 color loops

7900 Ignition Series, set of 8 color loops including:

7904 Spark Plug Service

7905 Removing Contact Points (external adjustment type)

7906 Installing External Adjustment Type Contact Points

7907 Replacing Points and Condenser (pivotless type part 1)

7908 Replacing Points and Condenser (pivotless type part 2)

Film: National Carbon Company, 30 East 42nd Street, New York, NY

"Automobile Cooling System," 16mm/color

Self-paced Skill Training Program: Ken Cook Transnational, Automated Teaching Systems, 9919 West Silver Spring Road, Milwaukee, Wisconsin 53225

Automotive Service Training Series:

Program 1. "Changing Tires"

Program 2. "Wheel Balancing"

Program 3. "Introduction to Mufflers and Exhaust Systems"

Program 4. "Tools and Equipment for Exhaust System Services"

Program 5. "Inspection and Removing the Muffler and Exhaust System"

Program 6. "Installing and Testing the Muffler and Exhaust System"

Program 10. "Adjusting the Brake Shoes"

Program 11. "Introduction to Alignment Angles"

Program 12. "Alignment Inspection: Tires and Parts"

Program 13. "Testing the Ball Joints"

Program 14. "Ball Joint Removal and Replacement"

Program 15. "Tie Rod End Removal and Replacement"

Program 16. "Measuring and Correcting Toe"

Program 17. "Measuring Alignment Angles: Camber, Caster, Steering Axis Inclination, and Turning Radius"

Program 18. "Correcting Caster and Camber"

LABORATORY ACTIVITIES

1. Service battery
2. Test battery specific gravity
3. Test battery capacity
4. Charge battery
5. Lubricate chassis
6. Repack front wheel bearings
7. Change engine oil and filter
8. Lubricate speedometer cable
9. Remove and replace water pump
10. Flush cooling system
11. Remove, test, and replace thermostat
12. Adjust fan belt tension
13. Pressure test cooling system
14. Check steering and suspension by tire wear
15. Rotate tires
16. Balance tires
17. Repair tire and tube
18. Inspect wheel for lateral and radial runout
19. Test ball joint wear
20. Inspect brakes
21. Adjust brakes
22. Adjust parking brakes

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23. Inspect brake drum
24. Measure drum wear
25. Safety check automobile

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AUTOMOTIVE PAINTING FUNDAMENTALS

DESCRIPTION

Automotive Painting Fundamentals ... provides the student with the fundamental knowledge essential for painting techniques and use of equipment. Types of paint, preparation of surfaces, use of spray guns, and common problems are covered.

LEARNING TIME

Hours: 90

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Remove old paint from a repaired portion of a vehicle using sander, liquid remover, and scraper.
2. Prepare materials for spraying.
3. Identify the name and function of each:
   a. sanding block
   b. sandpaper
   c. rotary disc grinder
   d. orbital disc grinder
   e. orbital flat sander
   f. tack rag
   g. squeegee
   h. strainer
   i. paper and tape
   j. paddle
   k. power-driven shaker
   l. color-mixing device
   m. spray gun
   n. respirator
   o. rubbing compounds
   p. machine polisher
4. Identify and demonstrate use of the suction feed and pressure feed spray guns and their components.
5. Cover and/or tape all bumpers, windows, and chrome.
6. Identify and describe automotive paint baking and drying processes and equipment.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success on objective tests.

MODULE OUTLINE

A. Fundamentals: Safety and Equipment
   1. automotive painting safety, ventilation and respiration
   2. basic shop equipment
   3. suction feed spray gun
   4. pressure feed spray gun
   5. spray equipment
      a. air compressors
      b. air transformers
      c. air line size and selection
      d. booths
   6. baking and drying

B. Preparation for Painting
   1. surface preparation
   2. masking procedures
   3. sanding abrasives
   4. hand sanding techniques
   5. power sanding techniques
   6. complete finish removal and metal conditioning

C. Selection and Application of Materials
   1. refinishing materials
   2. undercoat application
      a. primer surfaces
      b. sealers
   3. enamel application
   4. lacquer application
   5. acrylic application
   6. interior repainting

D. Paint Mixing
   1. topcoats
      a. selection
      b. color determination
      c. color matching and correction
      d. color tinting techniques

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2. mass-tone and tint-tone methods

E. Spray Gun Operation and Cleaning

1. adjustment and spray patterns
2. setups
3. cleaning
   a. suction feed
   b. pressure feed
4. spraying techniques
5. defective spray patterns

F. Paint Problem Identification

1. bubbles, blisters, and pop-ups
2. chipping
3. color mismatch
4. cracked/checked finish
5. craters and fisheyes
6. contamination
7. lifting
8. marks
9. orange peel
10. overspray
11. peeling
12. sags and runs
13. slow drying
14. water spotting
15. wrinkling
16. mottle

G. Polishing, Detailing, and Minor Repair

CURRICULUM MATERIALS

Automotive Collision Work (text), 4th edition, Edward D. Spicer. American Technical Society, 848 East 58th Street, Chicago, Illinois 60637

Automotive Painting Course, Hoffman Occupational Learning Systems, 4423 Arden Drive, El Monte, CA 91734

Course consists of course flow chart, course narratives, trainee work plans, terminal performance objectives, and the following filmstrips:

32-1301 "Fundamentals: Safety and Equipment," 9 modules

32-1302 "Preparing for Painting," 6 modules

32-1303 "Selection and Application of Materials," 6 modules

32-1304 "Paint Mixing and Matching," 4 modules

32-1305 "Spray Gun Operation and Cleaning," 6 modules

32-1306 "Paint Problems," 16 modules

32-1308 "Polishing, Detailing, and Minor Repairs," 4 modules

LABORATORY ACTIVITIES

Prepare and paint automobile metal surfaces

LABORATORY MATERIALS

To be drawn from shop equipment supplies

AUTOMOTIVE PAINTING APPLICATIONS

DESCRIPTION

Automotive Painting Applications ... is designed to develop the skills of the student in solving painting problems and performing satisfactory paint jobs. The student will do extensive preparation and painting on repaired automotive body surfaces.

LEARNING TIME

Hours: 90

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Cover and/or tape all bumpers, windows, and chrome.
2. Remove old paint from any repaired portion of a vehicle using sanders, liquid removers, and scrapers.
3. Finish paint automobile exterior and interior metal surface to the acceptable standard of quality.
4. Match colors.
5. Apply special effects such as wood grain transfer, vinyl top, pin stripes.
6. Demonstrate an ability to solve painting problems.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success on objective tests.

MODULE OUTLINE

A. Review of Basic Procedures

B. Special Paint Problems
   1. bubbles, blisters, and pop-ups
   2. chipping
   3. color mismatch
   4. cracked/checked finish
   5. craters and fisheyes

6. contamination
7. lifting
8. marks
9. orange peel
10. overspray
11. peeling
12. sags and runs
13. slow drying
14. water spotting
15. wrinkling
16. mottle

C. Special Effects
1. vinyl tops
2. trim (chrome and stripes)
3. wood grain transfer
4. glamour coats

D. Polishing, Detailing, and Minor Repair

CURRICULUM MATERIALS

Automotive Collision Work (text), 4th edition, Edward D. Spicer. American Technical Society, 848 East 58th Street, Chicago, Illinois 60637

Automotive Painting Course, Hoffman Occupational Learning Systems, 4423 Arden Drive, El Monte, CA 91734

Course consists of course flow chart, course narratives, trainee work plans, terminal performance objectives, and the following filmstrips:

32-1304 "Paint Mixing and Matching," 4 modules

32-1306 "Paint Problems," 16 modules

32-1307 "Special Effects," 6 modules

32-1308 "Polishing, Detailing, and Minor Repairs," 4 modules

LABORATORY ACTIVITIES

1. Surface preparation of the exterior of a repaired automobile for paint application:
   a. sanding
   b. cleaning
   c. priming

2. Masking
3. Painting
4. Sealing
5. Refinish an interior
6. Apply special effects
7. Removal of exidized paint
8. Polish and detail practice

LABORATORY MATERIALS

To be drawn from shop equipment supplies

AUTOMOTIVE BODY REPAIR

DESCRIPTION

Automotive Body Repair ... provides an overall knowledge of correction and repair of damaged automobiles. The student will do body repair and maintenance work on exterior and interior surfaces. Estimating the cost of repair work is also included in this module.

LEARNING TIME

Hours: 100

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Lay out, cut, and drill metal pieces for replacing damaged sections.
2. Straighten and smooth sheet steel.
3. Align and fasten metal sections in place.
   a. fenders and panels
   b. hoods
   c. doors
   d. trunks

*4. Align and straighten frames.

*5. Align body shells.

*6. Remove and replace trim and glass.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success in objective tests.

*Advanced units available only at a regional skills center

MODULE OUTLINE

A. The Role of the Automotive Repairman

B. Measurement

C. Basic Hand Tools and Fasteners

D. Power Tools

E. Filing and Sanding

F. Body and Frame Construction

G. Metal Bumping and Dinging

H. An Approach to Collision Jobs

   1. extent of damage

   2. typical jobs

   3. replacement vs repair

I. Shrinking, Soldering, Welding, and Cutting

J. Doors, Hoods, and Deck Lids

K. Frame Straightening

L. Refinishing Practices

M. Body Fillers

N. Fiber Glass

CURRICULUM MATERIALS

Automotive Collision Work (text), 4th edition, Edward D. Spicer. American Technical Society, 848 East 58th Street, Chicago, Illinois 60637

Automotive Body Repair Course, Hoffman Occupational Learning Systems, 4423 Arden Drive, El Monte, CA 91734

Course consists of course flow chart, course narratives, trainee work plans, terminal performance objectives, and the following filmstrips:

32-1501 "Basic Hand and Power Tools and Fasteners," 3 modules

32-1502 "Filing and Sanding," 5 modules

32-1503 "Welding, Cutting and Metal Shrinking," 4 modules

32-1504 "Body Fillers," 3 modules

32-1505 "Automotive Glass and Trim," 5 modules

LABORATORY ACTIVITIES

1. Body repair work on damaged automobiles including removal, repair, and alignment of:
   a. doors
   b. fenders and panels
   c. hoods and trunks
   d. frame
   e. body shell
   f. trim

LABORATORY MATERIALS

To be drawn from shop equipment supplies

ORIENTATION TO WELDING

DESCRIPTION

Orientation to Welding ... provides the student with an overview of the career opportunities in the welding industry. A brief history of welding leading to modern techniques establishes a background. Occupational choices and the accompanying standard of living are reviewed, and program organization and shop routine are established.

LEARNING TIME

Hours: 8

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Describe a brief history of welding, emphasizing the extent and importance of the present day welding industry.
2. Identify at least four areas of career opportunity in the welding field.
3. Identify the salary range expected in typical welding job categories.
4. Describe course routine including methods of study, laboratory practice, and testing procedure.

Acceptable achievement will be determined by a minimum success of 80% on written and objective tests.

MODULE OUTLINE

A. History of Welding
   1. origins
   2. increasing use of metals
   3. improved technology

B. Career Opportunity
   1. industry
   2. trade

3. technical
4. sales
5. engineering

C. Employment Opportunities and Pay Scale
1. national
2. regional
3. local

D. Course Organization
1. course outline
a. content
b. standards of competency
c. methods of evaluation
2. daily routine

CURRICULUM MATERIALS

Modern Welding (text), Althouse, Turnquist, and Bowditch. Goodheart-Willcox Company, Homewood, Illinois 60430

Film Loop: Encyclopedia Britannica Educational Corporation, 425 North Michigan Avenue, Chicago, Illinois 60611

"Welders-Oxygen and Arc Cutters"

Charts: Hobart Trade School, Box EW-157, Troy, Ohio 45373

"AC/DC Transformer Rectifier Arc Welder"

"Types of Welds"

"Typical Welded Joints"

"Welding Positions"

Newspaper want ads, union and industry personnel literature, U.S. Department of Labor forecasts

Handout sheets outlining course, objectives, standards of competency, and methods of evaluation

LABORATORY ACTIVITIES

None specified

LABORATORY MATERIALS

None specified

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FUNDAMENTALS OF WELDING

DESCRIPTION

Fundamentals of Welding ... acquaints the student with the properties of steel, how it is produced, and the effect of high temperatures. The nature of fusion and the manner in which it is achieved are demonstrated. The principles of welding and cutting are reviewed as well as the sources of energy used in the processes. The student is shown the relationship between temperature of metals and their dimensional stability. Safety procedures are stressed and the student is tested to assure safety awareness.

LEARNING TIME

Hours: 12

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Describe the means by which iron and steel are produced.
2. Describe the importance of high temperature in producing iron and steel.
3. Identify those basic properties of commonly used steels which affect the welding/cutting process.
4. Describe the nature of fusion and the manner in which it is achieved with oxy and arc equipment.
5. Describe the differences between fusion and nonfusion and the manner in which brazing and silver soldering are accomplished.
6. Describe the method used in separating metals.
7. Identify machine and handheld equipment.
8. Identify the various sources of welding energy.
9. Describe the properties of oxyacetylene and electrical energies which affect the welding process.
10. Describe the effects of heating upon the dimensional stability of metals.

11. Describe the problems of heating and cooling cycles and the dangers of incorrect welding sequences with metals.

12. Describe the process of heat conditioning.

13. Identify proper safety equipment and procedures used in the shop areas.

Acceptable achievement will be determined by successful accomplishment of laboratory activities and a minimum of 80% success on objective and written tests.

MODULE OUTLINE

A. Basic Ferrous Metallurgy
   1. production of iron
      a. mining the ore
      b. blast furnace production
   2. production of steel
      a. methods
      b. types
      c. properties

B. Principles of Welding
   1. fusion
      a. arc
      b. oxy
      c. resistance
   2. nonfusion
      a. brazing
      b. silver soldering

C. Cutting
   1. type
      a. flame
      b. arc
   2. means
      a. manual
      b. machine

D. Heat Sources
   1. oxyacetylene
   2. electricity
   3. oxyhydrogen
   4. air/acetylene
   5. air/fuel gas

E. Effects of Heat
   1. expansion
   2. contraction
   3. conditioning
      a. hardening
      b. annealing
      c. normalizing
   4. stresses
      a. internal
      b. external

F. Safety
   1. personal
      a. eye protection
      b. skin protection
   2. environmental
      a. ventilation
      b. screening nonwelders
      c. storage
      d. housekeeping
   3. accidents
      a. procedure
      b. reports

CURRICULUM MATERIALS

Welding Processes and Power Sources (text). Hiller Electric Company, Appleton, Wisconsin 54911

Modern Welding (text), Althouse, Turnquist, and Bowditch. Goodheart-Willcox Company, Homewood, Illinois 60430

Films: Armco Film Library, 703 Curtis Street, Middleton, Ohio 45042

"Iron Ore from Labrador," 18 minutes, 16mm/color

Bethlehem Steel Corporation, Advertising Division, Bethlehem, Pennsylvania 18016

"The Toughest Inch," 28 minutes, 16mm/color

American Society for Metals (ASM), Film Programs Inc., 2238 Euclid Avenue, Cleveland, Ohio 44115

"Heat Treatment of Steels," 30 minutes, 16mm/color

"How Metals Behave," 30 minutes, 16mm/color

"Iron Carbon Alloys," 30 minutes, 16mm/color

"Metal Crystals," 30 minutes, 16mm/color

LABORATORY ACTIVITIES

1. Collect, mount, and label samples of various metal types for display
2. Discuss the properties of various metals
3. Discuss the principles of oxy and arc welding
4. Practice filling out accident report
5. Locate safety equipment in shop and practice fitting safety apparel

LABORATORY MATERIALS

variety of metal samples

sample accident reports

safety equipment

safety apparel

BASIC FUSION AND NONFUSION PROCESSES

DESCRIPTION

Basic Fusion and Nonfusion Processes ... introduces the use and operation of welding and brazing equipment for welding, cutting, brazing, and soldering. The student demonstrates an ability to perform simple exercises using the hand arc welder, hand gas welder, soldering kits, and single- or double-stage torches.

LEARNING TIME

Hours: 30

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Identify the name and function of important parts of basic hand arc, gas welding, and brazing equipment.
2. Set up and connect basic hand welding equipment, including
   a. adjust regulators, torch, and flame
   b. strike an arc
3. Demonstrate ability to weld a simple bead using hand gas and arc welding equipment.
4. Demonstrate ability to make a 45° bevel cut using a cutter torch.
5. Demonstrate ability to make a flat butt weld with light material using hand gas welding equipment.
6. Demonstrate the ability to interpret the color/temperature relationship effect on fluxing and brass flow in nonfusion processes.
7. Demonstrate the ability to braze weld to acceptable field standards.
8. Demonstrate the ability to run silver around pipe with 100% penetration.
9. Demonstrate the ability to join stainless steel to field standards of quality.

Acceptable achievement will be determined by accomplishment of laboratory activities equal to field standards of quality and a minimum of 80% success on objective and written tests.

MODULE OUTLINE

A. Review of Safety in the Shop

B. Manual Oxyacetylene
   1. equipment
   2. function and applications
   3. setting up
   4. torch and flame adjustment
   5. rod selection
   6. welding a bead
   7. cutting and flat butt welding of light material

C. Manual Arc Welding
   1. equipment
   2. function and applications
   3. setting up
   4. strike an arc
   5. electrode selection
   6. welding a bead
   7. flat butt welding and light material

D. Braze Welding Process
   1. equipment and applications
   2. braze welding of cast iron
   3. silver soldering
   4. hard surfacing

CURRICULUM MATERIALS

Smith's Short Course for Gas Cutting, Welding, Brazing. Education Department, Smith Welding Equipment, Division of TESCOM Corporation, 2600 Niagara Lane North, Minneapolis, Minnesota 55441

Modern Welding (text), Althouse, Turnquist, and Bowditch. Goodheart-Willcox Company, 123 West Taft Drive, South Holland, Illinois 60473

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Trade Welding Syllabus (teacher's guide). The University of the State of New York, State Education Department Bureau of Secondary Curriculum Development, Albany, NY 12224

LABORATORY ACTIVITIES

1. Make a simple bead weld using
   a. manual gas welder
   b. manual arc welder
2. Make a simple butt weld using
   a. manual gas welder
   b. manual arc welder
3. Make a 45° bevel cut using a torch
4. Braze weld
   a. a butt joint on heavy steel plate
   b. a knob on cast iron
   c. a bevel butt joint in cast iron
5. Silver solder on steel
6. Hard surface a piece of steel plate

LABORATORY MATERIALS

See the laboratory materials in the Arc Welding and Gas Welding Modules

READING SHOP DRAWINGS

DESCRIPTION

Reading Shop Drawings ... is an individualized instructional program which prepares the student to interpret, understand, and use typical shop drawings. Complete background information is provided including the basic use of blueprints, their preparation, duplication, storage, filing, and revision procedures. Emphasis is placed on those symbols, codes, keys, abbreviations, and drawing conventions found on most manufacturing drawings today. A comprehensive study is presented of decimal equivalents and their use as related to dimension, tolerance, and screw thread. The student learns to dimension objects using decimals in conjunction with related fractional sizes.

LEARNING TIME

Hours: 12

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Identify drawing types and sizes.
2. Identify how drawings are prepared, duplicated, stored, and filed.
3. Identify arrangement of drawings and the relationship between drawings by their numerical identification.
4. Identify construction lines and dimension lines as used in multiview drawings.
5. Identify center lines, hidden lines, and break lines, and describe their function.
6. Identify front, top, and side views of objects in drawings.
7. Demonstrate proper methods of dimensioning items in drawings.
8. Identify characteristics and functions of sectional views and cross-hatching.
9. Identify cutting plane lines and related symbols.
10. Recognize thread types and components of threads that appear in drawings.

11. Use decimals in dimensioning items in drawings.
12. Identify the types of keys and their applications used in drawings.
13. Demonstrate a knowledge of the basics of reading drawings.
14. Identify types of machine fits, related tolerances, and drawing designations.
15. Identify bill of materials and operation records and describe their function.

Acceptable achievement will be determined by a minimum of 80% success on objective tests.

MODULE OUTLINE

A. Drawing the Language of Industry
   1. introduction
   2. types and sizes
   3. processing
      a. preparation
      b. duplication
      c. storage and filing
   4. part number systems

B. Basic Lines I
   1. basic drafting review
   2. multiview drawings
      a. construction lines
      b. dimension lines

C. Basic Lines II
   1. additional basic lines
      a. centerlines
      b. hidden lines
      c. break lines
   2. object views
      a. front
      b. top
      c. side

D. Basic Lines III
   1. review combinations of lines
   2. dimensioning
   3. steps to reading blueprints

E. Sectional Views
   1. introduction to sectional views and cross-hatching
   2. cutting plane lines
   3. related symbols

F. Threads and Gears
   1. types, characteristics, and function
   2. components

G. Decimals and Drawing Conventions
   1. uses in dimensioning
   2. tolerances
      a. upper limits
      b. lower limits
   3. related problems

H. Keys and Auxiliaries
   1. types
   2. terminology
   3. applications
   4. auxiliary drawings
      a. examples
      b. importance

I. Working Drawings
   1. use
   2. additional symbols and abbreviations
   3. scale markings

J. Identifications and Instructions
   1. machined fits
      a. types
      b. tolerances
      c. designations

2. part numbers
    a. piece parts
    b. subassemblies
    c. final assemblies
3. forms
    a. bill of materials
    b. operation records

CURRICULUM MATERIALS

Ken Cook Co., Automated Teaching Systems, 9929 West Silver Spring Road, Milwaukee, Wisconsin 53225

"Blueprint Reading Course," set of 10 audio-visual self-paced learning programs which fit the Mark 9 Student Response System. Workbook and test sheets, instructor's manual

LABORATORY ACTIVITIES

None specified

LABORATORY MATERIALS

None specified

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ARC WELDING

DESCRIPTION

Arc Welding ... introduces the student to the equipment, nomenclature, and function of arc welding. The process of setting up and striking an arc is practiced. The hazards inherent to or attendant to arc welding are made apparent. The student demonstrates an ability to maintain a uniform bead achieving total fusion in common types of welds.

LEARNING TIME

Hours: 25

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Identify the name and function of the important parts of arc equipment.
2. Set up and strike an arc.
3. Describe the hazards associated with arc welding and the procedures designed to minimize the danger involved.
4. Describe the effects of the four fundamental factors on the quality of a weld.
5. Demonstrate beginning ability to run a bead.
6. Demonstrate ability to maintain uniform arc length and rate of travel.
7. Demonstrate an ability to maintain uniform beads.
8. Demonstrate the ability to restart an arc achieving total fusion and uniform appearance of the beads.
9. Demonstrate an ability to adjust current settings for each rod size.
10. Demonstrate an ability to weld uniformly with a smooth weld-to-plate transition.
11. Demonstrate an ability to weld corner and edge joints without overlapping or eroding edges and without leaving craters.

12. Describe the unfavorable results if slag is included in the weld.

13. Describe the degree of penetration necessary.

Acceptable achievement will be determined by successful accomplishment of laboratory exercises and a minimum of 80% success on objective and written tests.

MODULE OUTLINE

A. Equipment
   1. nomenclature
   2. function
   3. fundamental factors
      a. current setting
      b. length of arc
      c. rate of travel
      d. electrode angle

B. Safety Orientation
   1. eye protection
      a. effect of rays
      b. approved filter plate
      c. head shield
      d. slag removal
   2. skin protection
      a. sparks
      b. sunburn
      c. synthetic fabrics
      d. protective clothing

C. Welding Procedure - Flat Position
   1. familiarization with current controls
   2. positioning stock
   3. manipulating electrode and holder
   4. adjusting apparel
   5. striking the arc
   6. running the bead

D. Stringer Beads - Flat Position

E. Padding - Flat Position

1. bead overlap
2. uniform height
3. smooth surface
4. stops and starts

F. Corner Weld, Open and Closed - Flat Position

1. hold to 90° corner
2. tack ends

G. Edge Joint - Flat Position

1. tack ends
2. full-width weld
   a. uniform bead
   b. maintain existing plate edges
   c. fill craters at end of pass
3. testing
   a. causes of defects
   b. means of avoiding defects

CURRICULUM MATERIALS

Trade Welding Syllabus (teacher's guide). The University of the State of New York, State Education Department Bureau of Secondary Curriculum Development, Albany, New York 12224

Modern Welding (text), Althouse, Turnquist, and Bowditch. Goodheart-Willcox Company, Homewood, Illinois 60430

Basic Arc Welding (text), Griffin and Roden. Delmar Publishers, Inc., 50 Wolf Road, Albany, NY 12205

Films: Lincoln Electric Company (LEC), Coit Road, Cleveland, Ohio 44117

"Prevention and Control of Distortion in Arc Welding," 20 minutes, 16mm/color

"Magic Wand of Industry - Arc Welding," 20 minutes, 16mm/color

Transparencies: DCA Educational Products, 4865 Stenton Avenue, Philadelphia, Pennsylvania 19144

"Arc Welding," series of 53 multicolored transparencies with overlays

LABORATORY ACTIVITIES

1. Practice the fundamental factors, current setting, length of arc, rate of travel, electrode angle
2. Practice making welds with different electrodes of varying diameters
3. Construct a box, approximately 8" x 8" x 8" with a nipple welded to one side; fill with oil or water; connect compressed air to test welds

LABORATORY MATERIALS

Personal:

- 24 aprons
- 24 pairs gloves
- 24 pairs goggles, flash
- 24 pairs goggles, safety
- 24 helmets
- 24 pairs shoes, safety
- 24 pairs sleeves

General:

- metal stock

Station (per):

- arc welding machine
- motor generator, DC
- transformer, AC
- rectifier, AC/DC
- electrode cable
- electrode holder
- ground cable
- ground clamp
- terminal lugs (2)
- hammer, chipping
- brush, wire
- electrodes

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ARC WELDING APPLICATIONS

DESCRIPTION

Arc Welding Applications ... acquaints the student with the variety of welds capable of being made with arc welding equipment. The emphasis is hands-on practice. In addition to the standard welds, the student becomes familiar with specialized welding of cast iron, stainless steel, and steel pipe. Instruction is primarily in the form of laboratory activities and job assignments.

LEARNING TIME

Hours: 25

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Maintain correct heat setting and electrode angle and proper bead placement.
2. Weld plates with one pass.
3. Weld plates of different thicknesses.
4. Demonstrate an ability to manipulate the electrode for weaving.
5. Demonstrate the ability to properly clean the weld.
6. Identify the appearance of proper penetration.
7. Describe the nature of the arc blow and the problems it creates.
8. Identify the meaning of trade terms.
9. Demonstrate an entry-level ability to:
   a. clean and bevel the plates
   b. align the plates, tacking them in the proper sequence
   c. fuse the plates, keeping the weld-face flat, without undercutting the sidewalls
10. Demonstrate an awareness of the gravitational pull on the molten bead and the fast-freeze electrodes used to counter it.
11. Demonstrate familiarity with the necessary current settings.
12. Demonstrate ability to maintain the rod angle and rate of travel necessary to obtain uniform beads.

13. Demonstrate an awareness of the tendency to undercut when vertical welding.

14. Demonstrate precautions to avoid the increased burn hazards in overhead welding.

15. Demonstrate an ability to adjust rod angle to meet varying conditions.

16. Demonstrate ability to weld a 100% melt-through without slag inclusions, the inner and outer beads being uniformly smooth.

17. Demonstrate sufficient knowledge of cast iron metallurgy to select the most effective methods and procedures for welding.

18. Identify cast iron samples.

19. Select and adjust equipment, prepare the metal, and weld cast iron by the arc method.

20. Classify by group, stainless steel samples provided, and adapt welding techniques to the sample characteristics.

21. Demonstrate ability to weld stainless steel.

22. Identify common aids to locating steel pipe welds.

23. Demonstrate accepted procedure in beveling edges when welding steel pipe.

24. Demonstrate proper pipe alignment and adherence to tacking sequence.

25. Demonstrate ability to set up welding machines for pipe welding.

26. Demonstrate proper procedure in manual welding steel pipe.

Acceptable achievement will be determined by accomplishment of laboratory activities equal to field standards of quality and a minimum of 80% success on objective and written tests.

MODULE OUTLINE

A. Fillet Weld - Top Joint

1. single bead
2. multiple bead
3. bead sequence
4. weaving the bead
5. distortion control
6. testing

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B. Butt Weld - Square Edge
   1. cleaning techniques
   2. proper penetration
   3. arc blow

C. Groove Weld - Flat Position
   1. terminology
   2. single V butt joint - single pass
   3. single V butt groove - multiple pass
   4. backing plate
   5. weaving the bead

D. Stringer Beads - Horizontal Position
   1. positioning stock
   2. manipulating the electrode holder
      a. angle to plate
      b. angle of travel
   3. striking the arc
   4. running the bead

E. Groove Weld - Horizontal Position
   1. single pass
   2. multiple pass
   3. weave

F. Stringer Beads - Vertical Position
   1. positioning stock
   2. manipulating electrode and holder
   3. striking an arc
   4. running a bead

G. Fillet Welds - Vertical Position
   1. stringer bead
   2. padding
   3. 3 pass
   4. multiple pass

H. Stringer Beads - Overhead
   1. positioning stock
   2. manipulating the electrode
   3. running bead
   4. padding

I. Fillet Welds - Overhead
   1. single pass
   2. 3 pass
   3. multiple pass

J. Groove Weld - Overhead
   1. 3 pass
   2. multiple pass
   3. backing plate
      a. with 100% melt-through
      b. without 100% melt-through

K. Nature and Properties of Cast Iron
   1. expansion characteristics
   2. type of metal
   3. recognition

L. Arc Welding of Cast Iron
   1. metal preparation
      a. preheating
      b. postheating
      c. controlled cooling
   2. electrode selection
      a. machinable
      b. nonmachinable
   3. process
      a. bead length
      b. peening

M. Arc Welding Stainless Steel
   1. selecting rod
   2. preparation - spatter proofing

3. current setting
    a. polarity
    b. power
4. identifying metal group
    a. martensitic
    b. austenitic
5. procedure
    a. stringer bead
    b. butt
        1) squared
        2) flanged
        3) beveled
    c. lap
    d. corner

N. Arc Welding Steel Pipe
1. preparation
    a. marking
    b. wrap-arounds
    c. contour markers
2. beveling
    a. hand-maintaining angle
    b. machine
    c. tip maintenance
3. slag removal
4. pipe alignment - tacking sequence
5. execution
    a. pipe setting - roll, fixed
    b. pipe axis - horizontal, vertical
6. machine settings
7. rod angle
8. maintaining keyhole - 100% melt-through
9. beat sequence

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CURRICULUM MATERIALS

Trade Welding Syllabus (teacher's guide). The University of the State of New York, State Education Department Bureau of Secondary Curriculum Development, Albany, New York 12224

Modern Welding (text), Althouse, Turnquist, and Bowditch. Goodheart-Willcox Company, Homewood, Illinois 60430

Basic Arc Welding (text), Griffin and Roden. Delmar Publishers, Inc., 50 Wolf Road, Albany, NY 12205.

Films: Lincoln Electric Company (LEC), Coit Road, Cleveland Ohio 44117

"Prevention and Control of Distortion in Arc Welding," 20 minutes, 16mm/color

"Magic Wand of Industry - Arc Welding," 20 minutes, 16mm/color

Transparencies: DCA Educational Products, 4865 Stenton Avenue, Philadelphia, Pennsylvania 19144

"Arc Welding," series of 53 multicolored transparencies with overlays

LABORATORY ACTIVITIES

1. Make sample welds of each of the techniques described
2. Test penetration with a 5% solution of nitric acid/alcohol
3. Weld plates of different thicknesses
4. Demonstrate slag trap formation and its effects on the weld quality
5. Practice keyhole technique for root penetration

LABORATORY MATERIALS

Personal:

- 24 aprons
- 24 pairs gloves
- 24 pairs goggles, flash
- 24 pairs goggles, safety
- 24 helmets
- 24 pairs shoes, safety
- 24 pairs sleeves

General:

- metal stock

Station (per):

- arc welding machine
- motor generator, DC
- transformer, AC
- rectifier, AC/DC
- electrode cable
- electrode holder
- ground cable
- ground clamp
- terminal lugs (2)
- hammer, chipping
- brush, wire
- electrodes

GAS WELDING

DESCRIPTION

Gas Welding ... acquaints the student with the nomenclature of gas welding equipment and the properties of various gases used in welding. Techniques of operating the oxyacetylene torch and uses of filler metal in various types of welds are demonstrated.

LEARNING TIME

Hours: 12

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Obtain without difficulty, neutral, oxidizing, and carburizing flames.
2. Identify the nature, function, and uses of the three flames.
3. Interpret AWS (American Welding Society) classification.
4. Demonstrate entry-level coordination in two-handed procedure.
5. Hold filler rod at the correct angle in developing torch and puddle control.

Acceptable achievement will be determined by successful accomplishment of laboratory exercises and a minimum of 80% success in objective and written tests.

MODULE OUTLINE

A. Equipment
   1. nomenclature
   2. setting up
   3. function
   4. properties of gases
      a. acetylene
      b. natural gas
      c. propane

5. flame adjustment
6. rod classes

B. Operating the Oxyacetylene Torch - Flat Position
1. techniques
a. forehand
b. backhand
2. operations
a. puddling (flat plate)
b. corner joint
c. edge joint
d. lap joint

C. Using Filler Metal
1. fillet joint
2. lap joint
3. butt joint
4. multiple layer welds

CURRICULUM MATERIALS

Trade Welding Syllabus (teacher's guide). The University of the State of New York, State Education Department Bureau of Secondary Curriculum Development, Albany, New York 12224

Modern Welding (text). Althouse, Turnquist, and Bowditch. Goodheart-Willcox Company, Homewood, Illinois 60430

Basic Oxyacetylene Welding (text), revised edition, Griffin and Roden. Delmar Publishers, Inc., 50 Wolf Road, Albany, NY 12205

Films: U.S. Bureau of Mines, Department of the Interior - Motion Pictures, 4800 Forbes Avenue, Pittsburgh, Pennsylvania 15213

"Oxyacetylene, Flame-Master of Metals," 19 minutes, 16mm/color

BFA Educational Media, 2211 Michigan Avenue, Santa Monica, California 90404

"Oxyacetylene Welding: Equipment," 16 minutes, 16mm/color

"Oxyacetylene Welding: Joining Steel," 14 minutes, 16mm/color

"Oxyacetylene Welding: Torch Techniques," 19 minutes, 16mm/color

LABORATORY ACTIVITIES

1. Become familiar with the equipment
2. Practice flame adjustment
3. Practice forehand and backhand torch techniques
4. Practice torch tip oscillation
5. Practice developing torch and puddle control

LABORATORY MATERIALS

Personal:

- 24 pairs gloves
- 24 sets goggles, welding
- 24 hand shields
- 24 leather capes

General:

- cutting machine
- attachment, circular cutting
- metal stock

Station (per):

- tank, acetylene
- tank, oxygen
- hose, acetylene
- hose, oxygen
- cart, gas bottle
- regulator set, double or single stage
- torch, welding, with tips
- torch, cutting, with tips
- lighter
- tip cleaner

CUTTING

DESCRIPTION

Cutting ... acquaints the student with the relative advantages of thermal and mechanical methods of cutting metals - arc, oxyacetylene, saw. The characteristics, equipment, and techniques used by these processes are explored. The hazards and appropriate safety procedures are stressed.

LEARNING TIME

Hours: 25

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Identify methods and characteristics of cutting metals.
2. Demonstrate an entry-level skill in all common cutting procedures.
3. Demonstrate the ability to select and set up the equipment needed to flame cut.
4. Demonstrate the ability to cut all common metals in all standard forms to field standards of quality.
5. Demonstrate the ability to set up, adjust and operate a torch cutting machine to field standards of quality and the capacity of the machine.
6. Demonstrate the ability to ignite and adjust the cutting flame.
7. Demonstrate the ability to remove, clean and replace the torch tip.
8. Demonstrate the ability to select, set up and operate to field standards all equipment necessary to electrode-cut common materials.
9. Describe the functions of power hacksaws and bandsaws and the hazards inherent in their operation.
10. Identify the processes which each type saw can perform.

11. Demonstrate an ability to set up and safely operate the power hacksaw for all common cuts.

Acceptable achievement will be determined by accomplishment of laboratory activities equal to field standards and a minimum of 80% success on objective and written tests.

MODULE OUTLINE

A. Methods of Cutting
   1. arc
   2. oxyacetylene
      a. manual
      b. machine
   3. saw
      a. hand
      b. power

B. Torch Cutting Manual
   1. equipment
      a. nomenclature
      b. function
      c. safety
   2. cutting steel
      a. light gauge plate
      b. heavy gauge plate
   3. chamfering steel
   4. cutting rivets
   5. cutting cast iron
   6. cutting pipe
   7. gouging
   8. piercing

C. Torch Cutting - Machine
   1. machine setup
      a. leveling track
      b. securing track
   2. speed adjustments

3. direction of travel
4. adjusting track and pinions
    a. torch position
    b. torch angle
    c. flame - igniting, adjusting
    d. torch tip - removing, cleaning

D. Electrode Cutting
1. equipment
    a. carbon arc
    b. metal electrode
    c. gouging electrode
2. processes
    a. beveling
    b. piercing

E. Power Sawing
1. equipment
    a. type - hack, band
    b. accessories
2. set up
3. cutting
4. safety

CURRICULUM MATERIALS

Trade Welding Syllabus (teacher's guide). The University of the State of New York, State Education Department Bureau of Secondary Curriculum Development, Albany, New York 12224

Modern Welding (text), Althouse, Turnquist, and Bowditch. Goodheart-Willcox Company, Homewood, Illinois 60430

Flame Cutting Facts. Smith Welding Equipment, Division of Tescom Corporation, 2633 S. E. Fourth Street, Minneapolis, Minnesota 55414

Films: Lincoln Electric Company, Coit Road, Cleveland, Ohio 44117

"Flame Cutting," 20 minutes, 16mm/color

LABORATORY ACTIVITIES

1. Practice cutting metals using thermal and mechanical means
2. Change and adjust blades of power sawing equipment
3. Operate the bandsaw (if the shop is equipped with this machine)

LABORATORY MATERIALS

Personal:

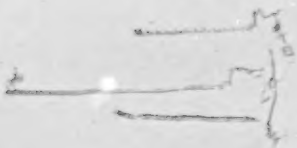
- 24 aprons
- 24 pairs gloves
- 24 pairs goggles, flash
- 24 pairs goggles, safety
- 24 helmets
- 24 pairs shoes, safety
- 24 pairs sleeves

General:

- metal stock

Station (per):

- 1 power hacksaw machine
- 1 bandsaw (optional)
- arc welding machine
- motor generator, DC
- transformer, AC
- rectifier, AC/DC
- electrode cable
- electrode holder
- ground cable
- ground clamp
- terminal lugs (2)
- hammer, chipping
- brush, wire
- electrodes



GAS WELDING APPLICATIONS

DESCRIPTION

Gas Welding Applications ... acquaints the student with the variety of welds capable of being made with oxyacetylene welding equipment. The emphasis is hands-on practice. In addition to the standard welds, the student becomes familiar with the specialized techniques of welding cast iron. Instruction is primarily in the form of laboratory activities and job assignments.

LEARNING TIME

Hours: 25

OBJECTIVES

Given the appropriate instruction and materials, the student will be able to:

1. Demonstrate the ability to control the molten puddle in all positions.
2. Demonstrate an ability to weld plates of different thicknesses to field standards of quality.
3. Demonstrate ability to maintain beads of uniform width.
4. Demonstrate ability to weld all common thicknesses of steel to field standards of quality.

Acceptable achievement will be determined by accomplishment of laboratory activities equal to field standards of quality and a minimum of 80% success on objective and written tests.

MODULE OUTLINE

A. Oxyacetylene Welding - All Positions
   1. puddling
   2. butt welds
   3. corners
      a. inside
      b. outside
   4. lap welds

5. multiple layer welds
    a. groove
    b. fillet

B. Operations
    1. running a bead
    2. butt welding
        a. light gauge steel
        b. heavy gauge steel
    3. fillet welding
        a. light gauge steel
        b. heavy gauge steel

C. Nature and Properties of Cast Iron
    1. expansion characteristics
    2. type of metal
    3. recognition

D. Oxyacetylene Welding of Cast Iron
    1. metal preparation
    2. equipment selection
        a. torch tip
        b. rod
        c. flux
    3. process
        a. flame adjustment
        b. oxide removal

CURRICULUM MATERIALS

Trade Welding Syllabus (teacher's guide). The University of the State of New York, State Education Department Bureau of Secondary Curriculum Development, Albany, New York 12224

Modern Welding (text), Althouse, Turnquist, and Bowditch. Goodheart-Willcox Company, Homewood, Illinois 60430

Basic Oxyacetylene Welding (text), revised edition, Griffin and Roden. Delmar Publishers, Inc., 50 Wolf Road, Albany, NY 12205

Films: U.S. Bureau of Mines, Department of the Interior - Motion Pictures, 4800 Forbes Avenue, Pittsburgh, Pennsylvania 15213

"Oxyacetylene, Flame-Master of Metals," 19 minutes, 16mm/color

BFA Educational Media, 2211 Michigan Avenue, Santa Monica, California 90404

"Oxyacetylene Welding: Equipment," 16 minutes, 16mm/color

"Oxyacetylene Welding: Joining Steel," 14 minutes, 16mm/color

"Oxyacetylene Welding: Torch Techniques," 19 minutes, 16mm/color

LABORATORY ACTIVITIES

1. Practice welding in all positions, with and without use of filler metal
2. Practice both forehand and backhand methods of welding
3. Make visual and destructive tests of welds
4. Practice proper sequence of welds with cast iron

LABORATORY MATERIALS

Personal:

- 24 pairs gloves
- 24 sets goggles, welding
- 24 hand shields
- 24 leather capes

General:

- cutting machine
- attachment, circular cutting
- metal stock

Station (par):

- tank, acetylene
- tank, oxygen
- hose, acetylene
- hose, oxygen
- cart, gas bottle
- regulator set, double or single stage
- torch, welding, with tips
- torch, cutting, with tips
- lighter
- tip cleaner

INERT GAS SHIELDED-ARC WELDING

DESCRIPTION

Inert Gas Shielded-arc Welding ... familiarizes the student with the function of shielding gas and the characteristics of tungsten inert gas (TIG) and metallic inert gas (MIG). Equipment nomenclature and operation are reviewed. Procedures for making welds in various positions on aluminum, magnesium and stainless steel are practiced.

LEARNING TIME

Hours: 25

OBJECTIVES

Given the appropriate instruction and materials, the student should be able to:

1. Demonstrate a basic knowledge of the nature, function, and characteristics of shielded-arc welding.
2. Describe the manner in which the different currents affect the weld.
3. Demonstrate an ability to select the current for any teacher-specified metal.
4. Demonstrate an awareness of the general and specific hazards in shielded-arc welding and procedures designed to minimize them.
5. Demonstrate the ability to select the electrode and adjust the equipment for welding any teacher selected joint and material.
6. Demonstrate the ability to select the gas and filler rod, and adjust the equipment for all MIG procedures.
7. Demonstrate an ability to TIG weld aluminum, magnesium, and stainless steel to field standards of quality.
8. Demonstrate ability to MIG weld to field standards of quality.
9. Demonstrate an ability to recognize defective welding and diagnose and correct the cause.

Acceptable achievement will be determined by accomplishment of laboratory activities equal to field standards of quality and a minimum of 80% success in objective and written tests.

MODULE OUTLINE

A. Equipment
   1. electrodes
      a. consumable
      b. nonconsumable
   2. shielding gases
      a. type
      b. function
   3. accessories
      a. rectifier
      b. power sources

B. Process
   1. principles of operation
      a. DC, reverse polarity
      b. electron and ion flow
      c. low and high density current
      d. transition current
      e. DC, standard polarity
      f. melt-off rate
      g. filler-wire treatment
      h. AC
      i. open circuit voltage
      j. pulse-arc
      k. arc stabilizing coatings
      l. power sources
   2. metal transfer
      a. globular
      b. spray

C. Safety
   1. clothing
   2. shield lens
   3. grounding
   4. ventilation

D. Tungsten Inert Gas (TIG)
   1. setting up equipment - selecting the electrode
   2. setting current for different metals
      a. heat
      b. AC or DC
      c. polarity

E. Metallic Inert Gas (MIG)
   1. setting up equipment
   2. setting current for different metals
   3. selecting shielding gas
   4. selecting filler metal

F. Procedures
   1. preparation
   2. positions
      a. butt
      b. lap
      c. fillet
      d. padding
      e. multiple pass
   3. materials
      a. aluminum
      b. magnesium
      c. stainless steel
   4. testing
      a. in process
      b. postweld

CURRICULUM MATERIALS

Trade Welding Syllabus (teacher's guide). The University of the State of New York, State Education Department Bureau of Secondary Curriculum Development, Albany, New York 12224

Modern Welding (text), Althouse, Turnquist, and Bowditch. Goodheart-Willcox Company, Homewood, Illinois 60430

Basic TIG Welding (text), Griffin and Roden. Delmar Publishers, Inc., 50 Wolf Road, Albany, NY 12205

Films: Aluminum Company of America, 1501 Alcoa Building, Mellon Square, Pittsburgh, Pennsylvania 15219

"How to Weld Aluminum - MIG," 20 minutes, 16mm/color

LABORATORY ACTIVITIES

1. Practice setting up equipment and selecting current for any specified metal
2. Select the electrode and adjust the equipment for any specified joint and material
3. Select gas and filler rod and adjust equipment for specified MIG procedures
4. TIG weld aluminum, magnesium and stainless steel to field standards of quality
5. Make MIG welds to field standards of quality
6. Make tests on welds in process and after completed

LABORATORY MATERIALS

For TIG welding machine:	For MIG welding machine:
TIG welding machine AC/DC	MIG welding machine AC/DC
water cooling system	spool holder, spool and wire feeder
argon gas, compressed	ground cable
ground clamp	ground clamp
ground cable	MIG gun cup for MIG gun
welding torch, TIG	argon gas, compressed
holder and caps for tungsten head	CO_2, compressed
tungsten tip	.040 steel wire
	3/32 aluminum wire

SUGGESTED FACILITIES LAYOUTS

The facilities descriptions and layout sketches following are intended only as guides. Any number of alternative facility plans could work equally well. For some schools, facilities for this program may already exist. In such cases, the following material may offer the instructor and administration some suggestions for making the facility more effective through minor alterations.

For other schools starting up a new program, it may be necessary to remodel existing facilities. In such cases, it should not be expected that the remodeled facilities will offer every advantage that can be achieved with new facilities.

Even if new facilities are to be provided, a school may be unable to support a complete laboratory either because of enrollment, space, staff, or financial limitations. In such cases, decisions must be made regarding minimum program essentials and then facilities designed to fit.

Whether new or remodeled, facilities may serve multiple or joint functions. Thus business and graphics production areas may be combined; art and graphics study areas could be shared; welding can be done in an auto shop; small engine and automotive shops can be combined; computer and business programs may share spaces; the various health and cosmetology programs can share a common suite; the electronics laboratory could be combined with a physical science laboratory.

Such combinations have served elsewhere to strengthen both programs. Students see the direct relationship of what they are doing with careers in another field, and faculty find professional stimulation and mutual support in working with colleagues in what have often been artificially separated disciplines.

AUTOMOTIVE MECHANICS LABORATORY

The automotive mechanics laboratory will house vocational courses in general auto mechanics which provide essential entry level skills in the auto mechanics industry. The general environment, layout, and equipment should simulate a modern, fully equipped auto garage for major and minor repairs, lubrication, wheel alignment, brake service, etc.

The total space allocation for this area is approximately 3000 square feet (SF) in a 30' x 100' configuration. This multipurpose laboratory is designed to operate as one continuous unit even though it is composed of several rather distinctive functional zones. One instructor could operate in this laboratory with a full class because he has vision to all spaces except into the parts and storage, which can be secured. The area is broken into the following general zones.

Live auto and motorcycle laboratory area. This area is composed of two 14' x 30' stations where full-sized automobiles could be driven through the 12' wide doors and three to four students could work in each stall at one time. One of the stalls could be provided with three to four motorcycle racks. The area should be a sealed concrete floor, sloped drain to a central sump consistent with local codes, provided with electrical service and compressed air. One stall should be provided with a hoist. The ceiling height should be a minimum of 14-15' to accommodate vehicles such as a Volkswagon bus on the lift.

The spaces are supported by a work bench area immediately in front of each automobile stall. The work benches should be metal with storage below and electrical service on the back splash of the counter.

Positive air movement must be provided to minimize carbon monoxide danger. Each vehicle bay must have a duct system to remove fumes from running engines. In addition, three duct connection points must be provided in the general work area to remove fumes from engines in motor mock-up units. An underground system, at least 8" in diameter, is preferred; however, an overhead system may be used. If an overhead system is used, the main exhaust stack should extend above the highest point on the roof line.

Lubrication, car service, and tire repair area. This area is composed of a single stall and should be provided with a portable hoist. It is supported with a lockable lubrication equipment cabinet, electrical and compressed air service from overhead reels, a tube testing tank, and tire repair equipment.

Parts cleanup. This area should be provided with a general curb around it and a drain in the center for the elimination of waste material. It is provided with a portable steam cleaner parts washer. The back wall should also be protected from water and stains by the use of an impervious material.

Alignment, wheel balance area. This area consists of one full stall equipped with a portable wheel alignment rack and a wheel balancing machine. The space can also double as a live auto repair stall.

Engine and small engine area. This area should be provided with an underground or overhead exhaust system to remove exhaust fumes from the engines that are operated on the movable engine stands. These stands are portable and can be arranged in the area to suit the instructor and students. The engine stand area is supported by two lockable tool cabinets. It is also in close proximity to the testing units. Some open space is available and will be used for equipment that is used in the basic laboratory area such as hoists.

Secure parts and storage area. This complete room is lockable for security of parts and supplies. The door can be operated as a dutch door for issue purposes. The room should be provided with a variety of open shelving for bulk materials and for smaller parts. One cabinet should be provided for hand and other small tools that are used for issue purposes.

Self-study and clean area. This area is provided with two carrels that can be used for single-loop type instructional materials or other prerecorded materials in instructing students how to perform certain operations involved in auto mechanics. It also has a work bench with an oscilloscope and can be used for carburetor or electrical work.

Support machine shop area. This area is intended to be a support area with a lathe, valve grinder, buffer, drill press, and similar types of equipment that are used for repairing parts and equipment worked on by students in other areas within the total laboratory.

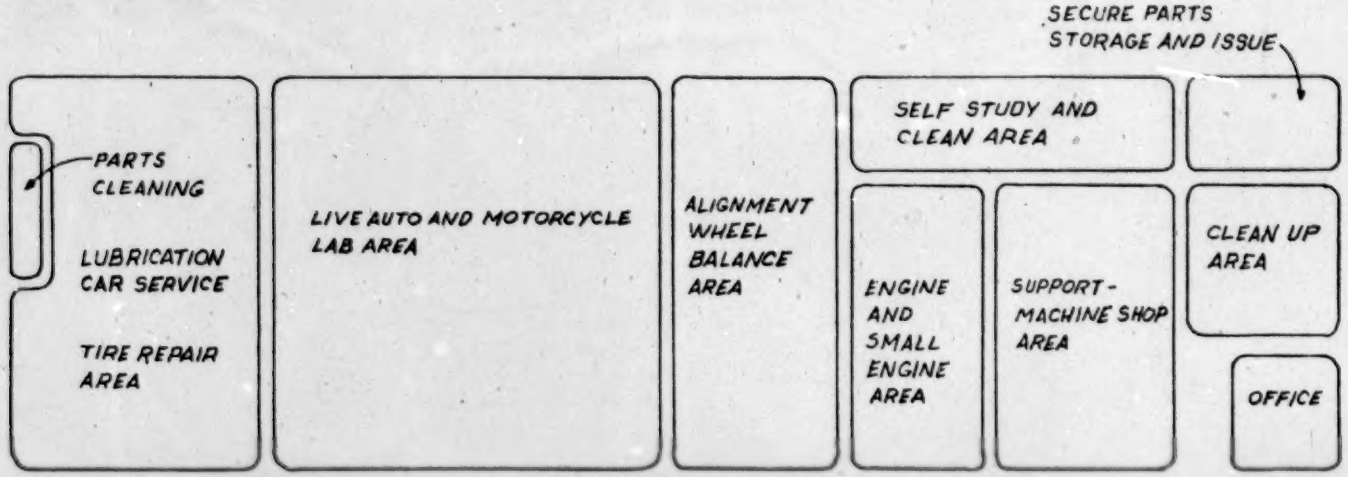
Locker and clean-up area. It is desirable that the sinks be shop sinks and accessible from both sides. The area is open to the rest of the laboratory intentionally. The lockers adjacent to the office should be kept below approximately 36" to 48" level in order to allow supervision from the office.

Outside of the laboratory. A fenced area should be provided outside the laboratory to accommodate at least 10 cars. This area should be provided with good access and a sloped drain which can be used for car washing. It should be ample for storage of automobiles coming to the laboratory and waiting for repairs.

General. There should be a drinking fountain in the general work area. Artificial illumination should provide 60-70 foot candles 30" above floor level. There should be 110 and 220 volt, double socket electrical outlets on 8' centers on all walls and on any support posts throughout the shop area. Provision must be made for a chain hoist to remove engines in at least one vehicle bay. Roof members may have to be reinforced above this bay.

A compressed air system, delivering a minimum of 60 pounds pressure per square inch, must be provided with outlets in each vehicle bay and one in the general work area. Walls in the automotive shop, except those areas where overhead doors are required, should have high level windows with bottom edge approximately 6' above floor level. This permits maximum use of wall areas for tool and equipment placement.

SUGGESTED AUTO MECHANICS LABORATORY
FUNCTIONAL ZONES



SUGGESTED AUTO MECHANICS LABORATORY
FUNCTIONAL ZONES

TAI
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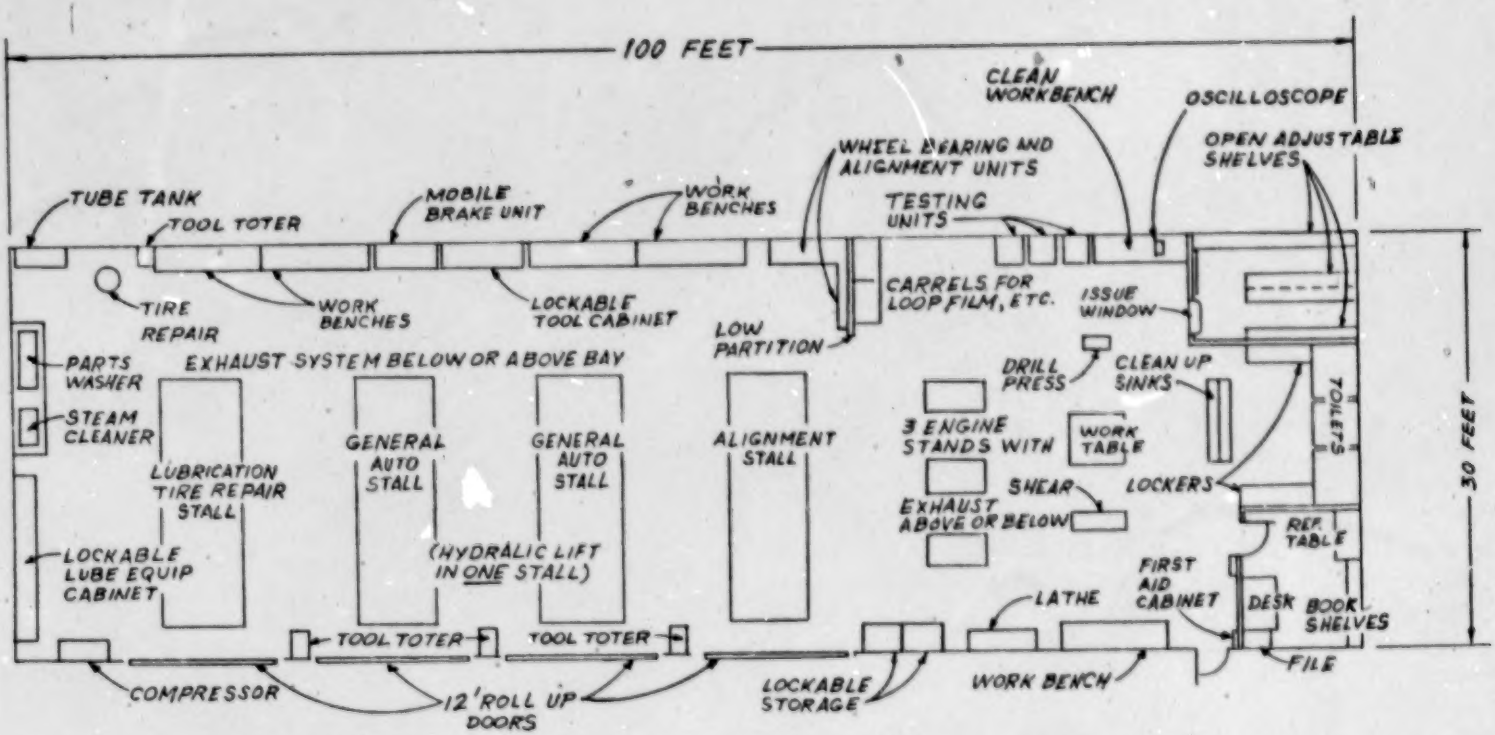
SUGGESTED AUTO MECHANICS LABORATORY

(30'x100')



SUGGESTED AUTO MECHANICS LABORATORY

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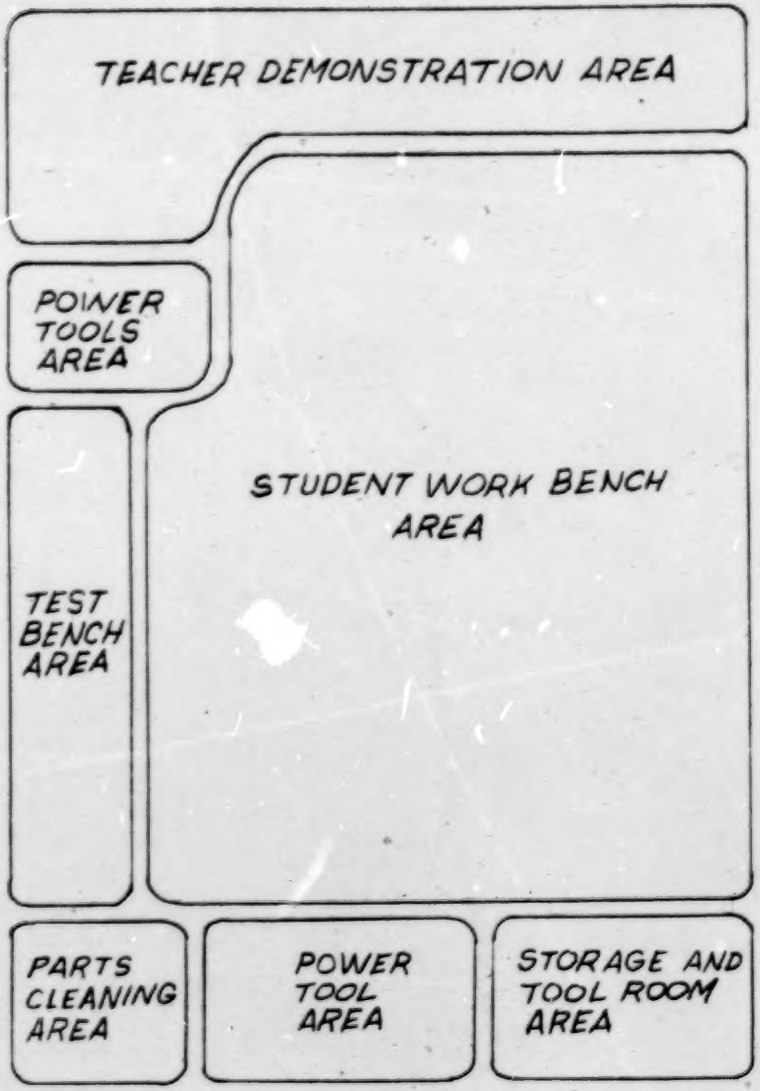
SUGGESTED SMALL ENGINE LABORATORY FUNCTIONAL ZONES



TAI
3/10/74

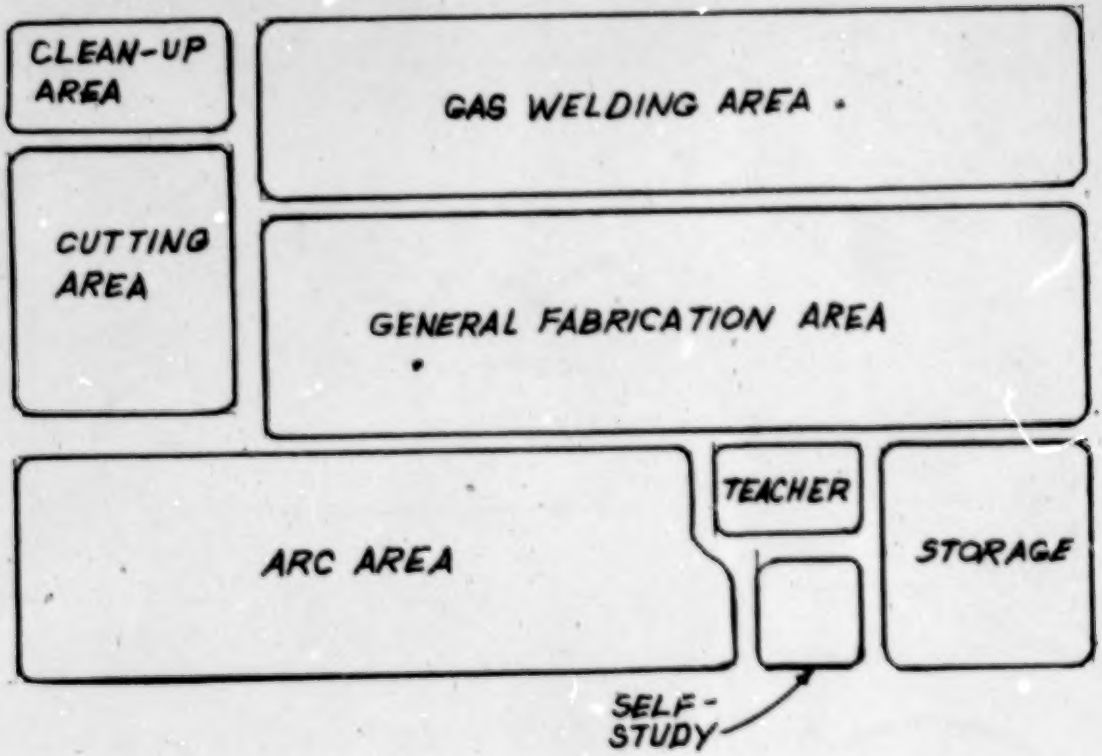
SUGGESTED SMALL ENGINE LABORATORY

SCALE 3/16" = 1'

TAI
3/10/74

SUGGESTED WELDING LABORATORY FUNCTIONAL ZONES

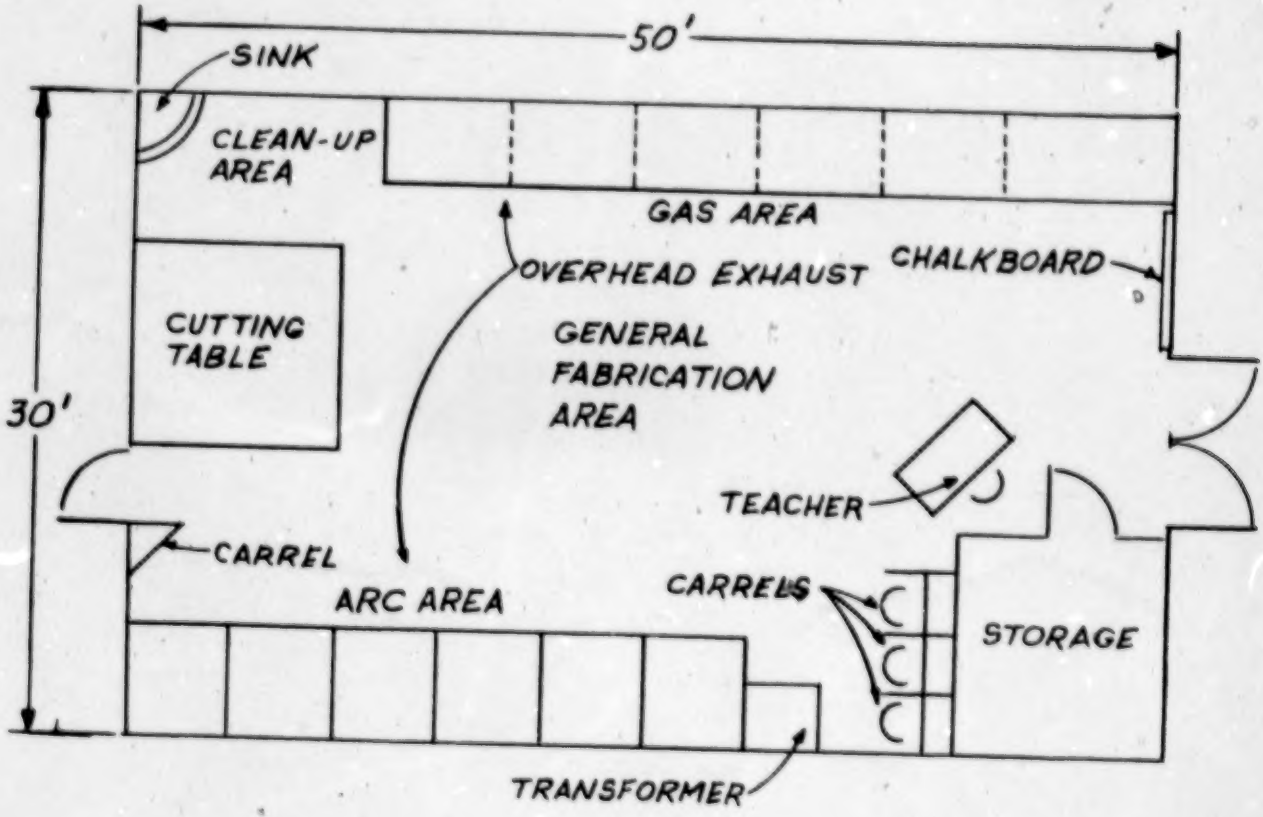
(OPEN PLAN ALLOWS TEACHER SURVEILLANCE OF ALL STATIONS)



SUGGESTED WELDING LABORATORY

SCALE 1/8" = 1'

(OPEN PLAN ALLOWS TEACHER SURVEILLANCE OF ALL STATIONS)



120

108

TAL 3/10/74